The characteristics and failure mechanism of Dewal landslide along Murree-Muzaffarabad road, Sub-Himalayas, Pakistan

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Abstract

In Pakistan, during the rainy seasons landslides occur mostly along the highways built in the mountainous terrain. These landslides cause loss of life, disruption to road traffic and reduce the tourist activities in the area. The present study deals with the characterization and failure mechanism of Dewal landslide along Murree-Muzaffarabad road, Sub-Himalayas Pakistan. The Dewal landslide was triggered for the first time in 2001 due to heavy rain fall and about 100-150 meters road was completely destroyed. However, landslide has been unstable since long. The main aim of the study was to investigate the controlling factors and failure mechanism of the Dewal landslide. For this purpose, intensive field investigation was carried out and in addition, laboratory test of the soil samples were performed. The paper also describes the geological characteristics of the area, to understand the causes and mechanism of the failure. According to the failure mechanism the heavy rain fall plays significant role in the landslide occurrence. On the basis of field investigation and laboratory test it was concluded that the Dewal landslide was mainly controlled by the geological factors rather than topographic factors. The results presented in this study could be helpful for planners and engineers for the continuity of traffic on Murree-Muzaffarabad road in future.

Late Cretaceous post-obduction siliciclastic sediments of Oman Mountains, north Oman

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Abstract

Thick siliciclastic sediments were deposited subsequent to Late Cretaceous (late Campanian-early Maastrichtian) Samail Ophiolite and Hawasina Complex obduction in north Oman. Siliciclastic sediments deposited in a foreland basin created during the emplacement phase of the ophiolite are termed as syn-obduction sequence of the Aruma Group. Subsequent to the ophiolite emplacement another group of siliciclastic sediments was deposited named as post-obduction sediments of the Qahlah, Al-Khawd, and Thaqab formations. The post-obduction siliciclastic sediments are exposed in isolated outcrops along the Oman Mountain front stretching from Ja'alan in south to Rawdah area in the north along the Batinah coast for about 500 km. Siliciclastic sediments of time-equivalent formation named as the Fayah Formation was deposited in mélange zone of Batain region in Northeast Oman associated with the Masirah Ophiolite.

The sediments of these formations are exposed in isolated outcrops in Oman Mountains and are highly variable in thickness. This paper describes the lithofacies association of the post-obduction siliciclastic rocks from various parts of the Oman Mountains to interpret the depositional setting, compositional variations to know about the unroofing history of the orogenic belt, and lateral variations in formation thicknesses to understand the depositional geometries developed in response to obduction. These sediments are underlain by the Cretaceous ophiolite rocks and unconformably overlain by the Maastrichtian/Paleogene carbonate rocks. The Qahlah/Al-Khawd Formation is comprised of a mixed lithofacies association of conglomerate and sandstone, including i) Massive matrix supported subfacies (Gms), ii)Massive, matrix-(sand) to clast-supported conglomerate subfacies (Gm), iii) Crudely-stratified conglomerate subfacies (Gcs), iv) cross-stratified conglomerate subfacies (Gt&Gp). The sandstone lithofacies is comprised of i) Pebbly sandstone subfacies (Ssp) and ii) Cross-bedded sandstone subfacies (Sst). The sediments were deposited in isolated segmented depressions each characterized by its source terrain depending on lithologies exposed in source area. Lithofacies associations, clast sorting and grain roundness suggest deposition in stream-dominated alluvial fans. Presence of *Loftusia*-bearing carbonate beds and bivalve-bearing conglomerate beds in different sections indicates occasional interruption of alluvial deposition by marine transgression. The marine transgression was wide spread though preserved only in few places, such as in Qalhat section near Sur.

The Fayah and Thaqab formations were deposited in isolated mélange zones in north and northeast Oman Mountains and are comprised of lithofacies associations which are closely associated with slope and sub-marine fan systems. The lithofacies association is comprised of five distinct facies associations; namely, i) coarsening-up sandstone, ii) conglomerate, iii) debris- flow, iv) turbidite, and v) inter-bedded sandstone and shale lithofacies. These sediments were deposited along a slope setting, possibly as olistostrome formed due to submarine slumping and sliding. Dewatering structures are common. These sediments were deposited in shallow water conditions by channelized flows. Based on the lithofacies associations described above, especially the dominance of debris-flow units and turbidites, the greater part of the Fayah and Thaqab formations are interpreted as having been deposited under a sub-marine fan setting. Only the upper part of the formation was deposited in shallow water setting before the onset of overlying carbonate deposits. The sub-marine fan system was active during the last stages of the Tethys Ocean closure at the time of onset of the Batain nappe.

Surficial geologic features and physical evidences of Noorpur thrust fault of Southeastern Hazara

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Abstract

Noorpur fault is an emergent thrust fault which is located in southeastern Hazara. It developed in Lora fold and thrust belt in which a number of neotectonic geologic activities are taking place, it is a tectono stratigraphic terrain. The strong geological and physical evidences of Noorpur thrust fault are reported during the field e.g. fault splay, fault geometry, displacement, repetition of strata, discontinuities, omission of strata, stream profile, hanging wall and footwall, nappe like structure, sense of slip, offsets, dragging, dip slip fault, low angle fault, attitude of beds, tectonic cleavage, steep ridges, allochthonous rocks, autochthonous rocks, flat and ramps geometry, heave, throw, slip lineations or slickensides, alluvial fans, fangglomerates, talus, fault contact, Tip line, fault trace, fault breccia, fault gouge, pseudotecalytes, cataclaysite, vein filled breccia, mylonites, foliated clays, striations, tectonites, fault related folds, fault scarp, fold and thrust belt, fossils, anticlines facing, mineralization, difference in sedimentary faccies, physiographic criteria; offset ridges, water springs, break in stream profile, lineament. Noorpur thrust fault may effect hydrocarbon and underground water resources and ore minerals in study area.The short review of Siesmicity interpretation of Noorpur thrust fault is mentioned at the end.

Reconnaissance studies on exploration of placer gold and base metals in district Hangu, Pakistan

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Abstract

Potential areas for mineral exploration can be targeted by using stream sediment geochemistry. The study area (Hangu District) covers the north eastern part of the Kohat Plateau and is dominantly composed of Kohat Formation (Eocene), Kamlial Formation (Miocene) and also Quaternary alluvium. The geochemical analysis of stream sediments in perspective of placer gold and base metals is attempted. The samples collected during field survey includes stream sediments, heavy mineral concentrates (HMC) and Quaternary deposits from different streams in the study area. For this study, concentrations of 10 elements including Au, Ag, Cu, Zn, Cr, Pb, Ni, Co, Cd and Mn were measured using atomic absorption spectrometer (Perkin Elmer 700).

For finding geochemical element dispersion in the study area, the data was statistically evaluated using univariate, bivariate and multivariate analysis. The GIS analysis was carried out on geochemical data to display single element concentration and multi element associations by constructing geochemical maps. The placer gold concentration in HMC samples (.024-.531ppm) was found higher than in stream sediment samples (0.013-0.146ppm) and Quaternary sediments (0.016-0.155ppm). The base metals concentration in HMC, stream sediment and Quaternary deposits samples is low, having mean value of about (.013-0.768ppm). The above data suggests that placer gold and base metals concentration in the study area is poor. It is, therefore, not recommended for economical and commercial scale extraction for Au, Ag and other base metals.

Pakistan's energy crisis, potential and security

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Abstract

Energy plays an important role in economic development. Due to limited supplies and lack of infrastructure development for provision of energy to main sectors of economy such as industrial and agricultural sectors, energy demand far exceeds the energy supply. The non-availability of sustained and affordable energy to these sectors has suppressed economic growth and created declining tendency for investment in the country.

The per capita energy consumption, which is one of the key development indicators as well as a measure of quality of life of a country, is low with only 14 million British thermal units (Btus), as compared to 92 million Btus for Malaysia and 34 million Btus for China. The input dependence of the country for energy at 24 percent is also high.

Pakistan has an immense potential for renewable energy growth and development. The three provinces of Pakistan i.e. Khyber Pakhtunkhwa, Baluchistan and Sindh provide vast untapped resources for hydropower, wind, solar and geothermal energy sectors. These sectors, therefore, represent an additional opportunity for the commercial sector and foreign governments to take on workable investments that will also assist Pakistan in exploiting its cleaner forms of energy.

Pakistan is blessed with a hydroelectricity potential of more than 50,000 MW. However, only 15% of this hydel potential has been harnessed so far. The remaining untapped potential, if properly exploited, can effectively meet Pakistan's ever-increasing demand for electricity in a cost-effective way.

Pakistan has a total installed power generation capacity of about 20,000 MW. Thermal plants using oil, natural gas and coal make up about 65 per cent of capacity (32% Public sector and 33% Independent Power Producers (IPPs), hydroelectricity making up 31 per cent, nuclear and alternate energy, 2 per cent each only.

Based on the present installed generation capacity, the country's Hydel: Thermal mix is 28:72. This is almost the reverse of the ideal Hydel: Thermal mix of 70:30, which would be much more cost-effective from the point of view of the country's overall economic development.

With no significant new generation capacity, Pakistan has to face a gap of more than 5000 MW between peak demand and firm supply in the years ahead. Estimates suggest that the loss due to this power shortages runs into tens of billions of rupees a year. Assuming overall economic growth of 6-7 percent, energy demand will double in 9-10 years.

National Energy Vision 2030 covers aspects like policy formulation, alternative energy sources, attraction of investments and developmental strategies. Overall response of the Government is to develop energy through (i) enhancement in the exploitation of hydropower, and exploration and production activities of oil, gas and coal resources, and to increase the share of coal and alternate energy in the overall energy mix, (ii) optimum utilization of the country's resource base to reduce dependence on imported oil through an institutionalized strategy, (iii) creating an environment conducive to the participation of the private sector and (iv) developing the local energy scenario in the context of regional perspective.

Structure of the area between Surghar and the Western Salt Range, NW of Kalabagh District, Mianwali, Punjab, Pakistan

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Abstract

The Surghar Range and the Kalabagh hills are the extension of the Western Salt Range and are comprised of Precambrian to Mesozoic Platform and Plio-Pleistocene fluvial sediments. The Eastern Surghar Range is a thin-skinned deformed structural province characterized by contractile structures. The dominant structural geometry in the range includes south-verging frontal thrust & folds, and steeply south dipping back thrusts. This geometry developed as a result of ramping from a basal d*é*collement at the base of Cambrian or Precambrian rocks. The contractile deformation systematically changes to transpressional deformation in the east along the Kalabagh Fault and a combination of salt tectonics and contractile deformation in the vicinity of the Kalabagh Hills. The structures related to salt intrusions include the development of normal fault in the vicinity of Kalabagh Hills that are believed to be gravitational collapse caused by the flowage and up section migration of Precambrian Salt Range Formation.

Propagation of earthquake normal fault rupture through uniform soil layer lying over bedrock

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Abstract

This paper presents a series of fault split box tests in which the behavior of earthquake normal fault was observed when propagated through alluvial soil to its surface starting from a bed rock. The tests were carried out with uniform dry sand having 60% relative density D_r, at three different bed rock fault angles of 45°, 60° & 75° and changing soil depth between 400mm and 450mm respectively with each bed rock fault angle. It came in observation that the bed rock normal fault bent towards the normal while propagating through the soil layer and there is a progressive shift in location of shear zone away from the bed rock fault with increase in normal stress due to increase in soil depth keeping other material properties such as soil grain size and nature, amount of slip on fault plain and inclination i.e. fault dip angle constant. Using Geo-PIV software (MATLAB module) it was calculated that with a given amount of slip on bed rock fault there was a corresponding amount of displacement along a shear zone in alluvial soil. From these observations it seems possible to predicate the shape and location of surface fault rupture knowing the amount, sense and dip angles of bed rock faults from some other geological source. This will help in applying proper building codes at a particular location in an area.

Reflectance spectroscopy of mineralized and non-mineralized rocks of Machalu, Astore and its surroundings, Northern areas of Pakistan

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Abstract

Spectral reflectance of alteration zones associated with particular mineralization are very helpful in finding the absorption and reflectance features of different minerals present in them. These reflectance curves are not only useful for identification of minerals and rocks in the alteration zones but are also very important for selecting different bands for remote sensing analysis of the unknown and inaccessible areas. The reflectance spectra of different types of mineralized and non-mineralized rocks of Machalu, Astore and its surrounding areas of northern Pakistan were obtained in the spectral range of 0.35–2.5 µm through ASD Spectro radiometer. The fresh rock samples show low spectral reflectance as compared to the mineralized altered rock samples. The minerals jarosite, goethite and hematite show depth of absorption minima in the range of 0.4-1.15 (µm) due to the presence of Fe, while, jarosite and limonite show depth of absorption features at 2.2 and 2.26 (µm) due to the presence of OH^- ions. Clay minerals Illite, montmorillonite and muscovite are showing absorption features at 1.4 (µm) and 1.9 (µm) due to the presence of OH^- ions and H_2O, respectively. Calcite shows deep absorption minima at 2.32 (µm), while, the mineral anorthite shows absorption features at 1.4, 1.9, 2.24 and 2.33 (µm). Olivine shows a slight depressed absorption feature at 1.07. The copper minerals malachite, chrysocolla and azurite show a broad absorption feature in the range of 0.6-0.9 (µm), a small absorption at 1.4 (µm) and a deep absorption at 1.93 (µm), respectively. The non-mineralized samples are showing high reflectance bands in the range of 0.6-0.8, 1.6-1.9, 2.0-2.3, 2.1-2.25 and 2.4-2.5 (µm) wavelength, while, the mineralized samples are showing reflectance bands in the range of 0.4-0.6, 1.3-1.8 and 2.1-2.2 (µm) wavelength. Band 1, 2, 3, 4, 5 and 7 of Landsat-8 and Band 1, 2, 3, 6, 7 and 8 of ASTER were selected for processing the remote sensing images.

Hydropower potential site investigation in Bhalgran using remote sensing and GIS techniques

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Abstract

The Northern hilly regions of Pakistan can be exploited for the Hydropower, which is a cost-effective and environmentally clean source of renewable energy. However, difficult and inaccessible terrain profile makes development of this potential a challenging task. In this paper a methodology has been developed to find location which offers a potential in its water resource for generating electricity. The investigations regarding feasibility of the hydropower project can be made without coming into physical contact, with the help of Satellite images and its interpretation. A stream flow of sufficient flow rates down significant slopes is necessary for sustainable electricity production. The study area selected for hydropower potential exploitation is Bhalgran, that is located at the east of Jhelum River, near Rawalakot city of Poonch district. Digital Elevation Model (DEM) was generated using the Shuttle Radar Topography Mission (SRTM) data, and point elevation data was utilized to derive natural head (H). Using the value of natural head (72m), power in megawatt (MW) was calculated which turned out to be 642MW. The results showed that the area was having enough potential for the generation of electricity.

GIS based sewerage design decision system (SDDS): A case study of model town Lahore

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Abstract

Sewerage network is the most efficient, economic, and the safe way to transport the industrial, domestic waste water .The drainage pipes installed are of limited size and the excessive rainwater and routine household waste water passes through it. In the absence of a proper sewerage system, residents of different localities are forced to drain sewerage on streets .In planning of the sewerage system most of the decisions are spatially dependent on right of way consideration and gravity of the water flow. GIS is the tool used to analyze the area topography, surface features, and the street networks, delineate the sub watersheds and to locate the manholes and sewerage network line length. This paper presents prove of concept how GIS is used in designing sewer network considering DEM, topography, streets and house parcel information. Sewerage design decision system (SDDS) is capable to generate network keeping in view the population of selected area, water flow accumulation, diameter of pipe line, distance between manholes and length of sewerage and turns into network. SDDS is a Predominantly GIS based sewerage system in Pakistan that efficiently create manholes at specific intervals, Create sewer lines between manholes and efficiently perform Hydraulics calculations .It designs the complete sewerage network with minimum human force. GIS Based sewerage design decision system (SDDS) is used to analyze and manage the major resource of the city. Model Town, Lahore, was as case study to compare existing networks and redesign the sewer network. Study proves that the SDDS is used for better decision making, estimation, monitoring of the waste water sewerage. The end result of this research is a very effective comprehensive GIS based sewerage Network Desktop Application designed for the identification of the disposal points. SDDS will maintain capacity of water, fulfill the sanitation authority requirements and give the outlook of well managed drainage system.

Application of geomatics techniques for geological and geomorphological survey of Murree Area, Pakistan

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Abstract

The geology and geomorphology of Murree area has been studied using Geomatics techniques. Classification approach using Landsat TM image and survey data has been adopted to prepare Geological map, while, making use of Hammond's landform analysis with ASTER DEM, the landform map of study area has been developed. To address possible reasons of slope failure on different landsliding sites in the study area, different capabilities of remote sensing and GIS were integrated, i.e. generation of Slope map, Aspect map, Stream orders, False color composite overlay analysis. Total 40 zones have been demarcated, with 20 zones representing unstable zones and 20 zones displayed as potentially unstable zones. It was concluded that the best option to conduct, cost and time effective, preliminary geological study on a large scale is the use of satellite images integrated with digital elevation model (DEM). Database provided in the form of results of this study can be supportive in hazard studies, disaster management and future development plans.

Exploration and economic evaluation of Au, Ag and base metals in District Swabi, Pakistan

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Abstract

District Swabi is located in the eastern part of Peshawar basin with wide spread streams mainly along River Indus. These streams transport a large quantity of clay, sand, silt and gravel and over a long distance. Field work was conducted in district Swabi in order to collect stream sediments and pan concentrate samples for better understanding of exploration in these areas. Field panning method was adapted for samples collection and a total of seventeen pan concentrate and twenty stream sediment samples were collected from the selected sites. Chemical analysis for Au, Ag and base metals was carried out using Atomic Absorption Spectrometry (AAS).

Results of pan concentrate samples indicate Ag, Cu, Pb, Zn, Ni, Cr Co, Cd and Mn which ranges in pan concentrate samples from 0 to 4 ppm, 0 to 350 ppm, 0 to 31 ppm, 2 to 63 ppm, 0 to 35 ppm, 0 to 69 ppm, 0 to 47 ppm, 0 to 6 ppm and 51 to 313 ppm respectively. Results of statistical analysis show that in pan concentrate samples, the highest concentration (ppm) of Au is 31.8, 9.0 and 3.0 from Bada khwar, Zarobai and Shewa Khwar. While the lowest concentration of Au is 0.003 ppm in Aadina khwar. Mean concentration of Au in pan concentrate samples is 2.7 ppm. In stream sediment samples Ag, Cu, Pb, Zn, Ni, Cr, Co, Cd and Mn ranges from 0.05 to 4ppm, 0 to 104ppm, 0.02 to 11ppm, 0.01 t to 38ppm, 0.02 to 653ppm, 0.02 to 45ppm, 0.02 to 9.3ppm, and 0.05 to 7 and 0.02 to 343ppm respectively. Results of all stream sediment samples shows that Au concentration is low in majority of the samples with values of less than 1 ppm with mean value of 0.3 ppm. Correlation matrix indicated that Au shows good correlation with Cu and Co in stream sediments, while in pan concentrate Au is not showing any association with other elements. Similarly Cu shows good association with Zn in both stream sediments and pan concentrate. Lead shows good correlation with Ag, Ni and Cd in pan concentrate, While Pb is showing good correlation with Zn, Cr and Cd in stream sediments. These two sampling media are showing different signatures for different elements.

From the results, it is concluded that anomalous concentration of Au is found in district Swabi with highest in Bada khwar, followed by Zor khwar and Shewa khwar near Naranji village. The grade of Au in these areas is high enough to be called economic placers. However, due to small scale and limited extent, these placers can't be extracted on commercial scale.

Economic geology of Heroshah chromite mines, Skhakot Qila Complex, NW Pakistan

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Abstract

Heroshah chromite deposits are part of Skhakot-Qila ultramafic complex associated with ophiolitic sequence in the vicinity of Main Mantle Thrust Zone (MMTZ) in NW Pakistan. The Heroshah chromite deposits are being mined regularly for chromite ore for the last five years at a rate of 70 to 80 tones per day. About eight mines were investigated in the current study, among which five mines are in operation while 3 have been abandoned due to ponding. 30-40 people are working in these mines out of which most are local. Ores are extracted through open pit and various underground mining techniques, e.g. adits, shafts, raises, winzes and crosscuts. However, the mining methods adopted in the area are unsatisfactory as they have badly affected the various other resources like land, water and biota in the study area.

Samples of ore and host rocks were collected from each working mine, and were studied in terms of petrographic features and geochemical characteristics. Field relationships and petrographic studies lead to identification of four types of lithologies i.e. chromitite, dunite, serpentinite and talc-serpentinite. Dunite, serpentinite and talc-serpentinite serve as host rocks for chromitite, among which dunite is the most dominant. Massive chromitite occurs as irregularly shaped layers, lenses and pods that are 2 cm to 2-3 m thick and 5 to 10 m long. Chromite also occurs in the form of disseminations and as an accessory mineral in the host rocks. One of the chromitite bodies is exceptionally large; whose average horizontal and vertical dimensions are 20 and 80 m, respectively. As such, it may be the largest among the known individual chromite bodies in Pakistan. Chromite is coarse to medium-grained, and the grains are subhedral to anhedral as well as amoeboidal and show alteration to ferritchromite along margins and intragranular cracks. Chromite bodies with nodular structure and pull-apart textures also occur.

The bulk chemical composition of chromite (wt.%) may be summarized as: Cr_2O_3 (21.56-32.00), Fe_2O_3 (8.57- 9.12) MgO (6.91-11.50) Al_2O_3 (11.60-16.40). Among other components, Zn, Ni, Co and Ti occur in trace amounts. The average value of Cr/Fe ratio is 2.6:1. On the basis of these geochemical features, the chromite ores are classified as beneficiable to refractory-grade. The alumina richer character of these chromite ores is also confirmed by mineral analysis through SEM.

In accordance with their distinctive tectonic setting, the structure, petrography and chemical characteristics suggest that the studied chromite deposit is podiform (Alpine) in nature and equivalent to the chromite deposits located at Shangla, Bajauar and Pranghar. It is further concluded that these deposits are minable at a profit and hence a beneficiation plant may be installed so as to uplift the socio-economic conditions of the area.

Subsurface structural interpretation of seismic profiles of Tajjal Gas Field of Lower Indus Basin Pakistan: A case study

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Abstract

Geographically Tajjal Gas field is located about 120 Kms south east of Sukkur in Sindh Province of Pakistan. Geologically Tajjal Gas Field (Gambat Block) lies in Lower Indus Basin -a proven Geological Province in the Islamic Republic of Pakistan. The field was discovered by OMV Pakistan in 1995 and is one of the productive fields having latitude 26^0 52' 50'' N and longitude 68^0 55' 60'' E. It is bounded by the nearby Gas fields i.e., Miano, Kadanwari and Sawan. The area is bounded by Pannu Aqil sub Basin in the north, Kirthar Sub Basin in the south, Indian Shield in the east and Kirthar Fold Belt in the West. This research pertains to the Interpretation of 60 Fold seismic data acquired by ENI Pakistan in November 1989 was used in SEG-Y format for Structural and Stratigraphical Interpretation. Since the study area is part of the Lower Indus Basin which is an extensional regime resulting extensive Horst and Graben Geometry that may be considered as probable hydrocarbon bearing zones. The area is known for the existence of stratigraphic, structural and combination of both traps. The organic rich shales within the Sembar Formation are the essential hydrocarbon generating source rock of this region including other parts of the Indus Basin. Sandstones of Lower Goru Formations are the primary reservoirs. Other reservoirs are Eocene to Paleocene carbonates and sandstone. The seismic data used for this research confirmed successfully the geological and stratigraphic set up. On the basis of regional stratigraphical set up, available data of nearby fields and following the continuity of seismic reflections results three main Horizons were marked and named as Possible Sui Main Limestone (at 1.1 sec), Upper Goru (1.2 sec) and Lower Goru (1.65 sec) Formations. Migration path for hydrocarbons with structural and stratigraphical traps have been identified on the seismic sections successfully. Continuous faults passing from different lithologies and formation provide traps for the accumulation of hydrocarbons. The lower Goru formation is the main proven reservoir rock in the study area. Goru sands have typical parallel package of sand beds on the seismic section. The range of two way time contours is from 1521 ms to 1627 ms. The contour mapping of 5 ms contour interval shows a closure of 500 m^2 at shot point # 260 of two horst structures with approximately 10 ms vertical throw on the east west trending seismic section TJ89-520 and in terms of depth it's approximately 15 meters. A small lead is also present at shot point 380 – 390 of closure 400 m^2 bounded by fault towards western side of the lower Goru level. These could be the locations for new prospects in the study area.

Importance of on-field seismic re-evaluation to understand seismic hazards (Nuclear power plants as case study)

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Abstract

Nuclear Power, for last many decades, has been considered a safe, economically viable, environment friendly and dependable source of energy globally. Due to energy deficiency and depletion of the conventional energy sources, the developing countries have also embarked on increasing nuclear share in their national energy mix. Therefore, a remarkable increase in nuclear energy has been observed in the developing world during the last decade, however, recent nuclear accident of Fukushima raised serious concerns on nuclear power plants safety against the external hazards such as earthquake. Consequently, it highlighted the need for re-evaluation of potential earthquake hazards from time to time. Taking into account the new insights from the Fukushima accident and all possible reasons of hazards and other events, it is concluded that although nuclear power plant site is selected on the basis of detailed site studies but it is now felt that these studies are to be updated from time to time. On-field seismic re-evaluation process if conducted in a continuous way is assumed very useful for understanding seismic hazards and can contribute to update the seismic hazards for the site. The poster focuses on importance of on-field seismic re-evaluation studies and its advantages for evaluating seismic hazards in a more detailed and updated way for nuclear power plants.

Microfacies, diagenesis and reservoir characterization of Sakesar Limestone Salt Range, Pakistan

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Abstract

The early to middle Eocene Sakesar Limestone of the Western Salt Range has been studied in detail for carbonate microfacies, depositional modeling, diagenetic fabric and reservoir properties. These studies are important in order to determine the nature and timing of depositional and digenetic processes which control the distribution of porosity and permeability and to measure lateral and vertical heterogeneity in facies types and reservoir rock potential. Ninety two rock samples were collected at three studied sections (i.e Dhak Pass, Zaluch Nala and Chhidru Nala). A total of 3 microfacies (SLF-1 to SLF-3) have been recognized on the basis of lithology and primary sedimentary depositional features.

The identified microfacies are, larger benthic foraminifera wack-packstone microfaceis (SLF 1), Foraminiferal-algal wack-packstone microfacies (SLF 2) and Brachiopod rich bioclastic wack-packstone microfacies (SLF 3). Based on paleoecology, sedimentary structures and microfacies type the Sakesar Limestone is suggested to be deposited in inner to middle ramp and middle ramp lagoonal environment.The absence of turbidite deposits, reefal facies, gradual facies changes and widespread tidal flat deposits indicate that the Sakesar Limestone was deposited in a carbonate ramp environment. Due to the great diversity and abundance of larger benthic foraminifera, this carbonate ramp is referred to as a "foraminifera-dominated carbonate ramp system". This suggests that during the Early Cenozoic, following the demise of the end Cretaceous rudist-coral assemblage, nummulitid (Nummulites, Assilinaand Operculina), orthophragminid (Discoyclina) and alveolinid (Alveolina) larger benthic foraminifera (LBF) thrived on shallow, oligotrophic enviornment of the Tethyan carbonate platforms.

Diagenesis is mainly constrained by microfacies. Features such ass-tylolites, calcitization, neomorphism, nodularity, various cement types (Blocky, Fibrous, Granular mosaic, Bladed, Drusy mosaic and Equant isopachous), stylolization and fracturing were found in majority of the samples from study area. Interpretation of these features indicating marine to meteoric to burial environment for studied samples from the Western Salt Range.

Porosity and permeability studies were carried out in order to account for hydrocarbon potential. Our results show the range of porosity interparticle to fractures with overall porosity greater than (20%). In the middle and lower part of the Sakesar limestone, high permeability (up to 0.17 MD) and low porosity-permeability (poro-perm) is present in some parts of the Sakesar limestone. The best reservoir quality is present in the middle and lower part of the Sakesar limestone. The Sakesar limestone beds in the study area are thick enough with suitable porosity and permeability values, which could be good targets for hydrocarbon exploration in future.

Propagation of dip-slip fault rupture through uniform soil cover

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Abstract

Substantial research work has been carried out after the earthquakes that caused damage to buildings due to earthquake ground shaking while less attention is given to the damage as a result of permanent ground failure caused by the propagation of an earthquake fault rupture. However, case histories from the recent earthquakes revealed significant damage occurred to the infrastructure as a result of fault-foundation interaction and that there exists a quite subtle interaction mechanism between the fault rupture and infrastructure. Moreover, there were many instances of satisfactory performance of buildings in such events.

The seismic codes (e.g Eurocode 8) correctly require that construction must be prohibited within the ‘‘immediate vicinity’’ of active faults, at least not without a specialized analysis and design. However, uncertainties associated with permanent ground deformation during the earthquake makes it more catastrophic because once the fault rupture emerges to the surface the next time it is not necessary that the fault rupture will follow the same path. Fault rupture propagates through the plane of weakness in the shear zone as a result of the previous fault rupture. The problems in designing structures become even greater when the fault trace in the bedrock is covered by recent alluvial deposits of considerable thickness (i.e. a few tens of meters). In such a case, even if the bedrock fault dip angle and the potential fault displacement are well established by a seismo-tectonic study, it remains unclear whether the fault rupture reach the ground surface and where would it be located and what will be the width of fault dislocation zone.

In order to understand the propagation of dip-slip fault through uniform soil cover lying over a bed rock, series of tests were performed in a split box. Split box is specially designed box where both normal and reverse faults tests can be conducted at various dip angles. Medium dense, dry sand is used in all the tests and is pluviated in the box to get the relative density, Dr ≈ 60 %. Digital images were taken as the fault rupture propagated into the soil for later image analysis using Geo-PIV technique. The effect of varying soil depth and fault angle from the bed rock on shape and location of normal and reverse fault on the surface was studied in detail. The propagation of fault rupture was found to be progressive as observed in previous studies. Initially, a small amount of displacement produced only general distortion in the soil. With further increase in fault displacement, deformation is associated along a shear localization, starting from the base of the soil layer and propagating upward. The reverse fault rupture decreased its dip as it approached the ground surface whereas the normal fault rupture increased its dip near the surface. The fault angle in the soil is primarily a function of dilation angle and dilates more near the surface with low effective stresses. The width of deformation zone is found to be a function of soil depth and it reduced as the soil depth increased. In both reverse and normal fault tests steep dip angles from the base produced pronounced fault scarp at the surface and required less displacement from the base for a fault to reach the surface. These model tests have provided further insight about the fault propagation and a hope that buildings can be designed and sighted in suitable place in order to avoid substantial damage.

Rock characterization and empirical design of support for a hydropower tunnel in Shangla, Khyber Pakhtunkhwa, Pakistan

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Abstract

The study site is located in Shangla District, Khyber Pakhtunkhwa. Geological and engineering geological mapping was undertaken along the tunnel corridor using topographic survey overlaid on satellite image. During engineering geological mapping, soil and rock units were identified and marked based on dominant lithologies. Discontinuity surveys were conducted along the tunnel route to get the information about the distribution, orientation and characteristics of the discontinuities for onward rock characterization using empirical methods; Rock Mass Rating (RMR) and Rock Tunneling Quality Index (Q).

Kinematic analyses were undertaken on discontinuity data in relation to the tunnel alignment using computer program Rock Pack III and DIPS. Possible modes of rock failure were assessed in representative tunnel sections using computer program UNWEDGE. Spot support based on the discontinuity data was suggested. All the discontinuity and subsurface investigations data were used to characterize the rock units for rock mass classification; R1-R4 based on RMR and Q values. Overall, 48% tunnel was found to pass through R1, 09% through R2, 30% through R3 and 13% through R4 of the total tunnel length of 5950m. Corresponding to each rock class, an empirical design of the support was finalized after analyzing the support elements provided by both empirical systems. The support designed for the tunnel comprises the steel ribs, shotcrete and rock bolts for R1-R4 rock classes.

Evaluation of rock cut slope for Sheraton hotel in Bahria Golf City, Islamabad

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Abstract

This paper is a case study on rock slope evaluation by using analytical and kinematic analysis of a 180m high and 350m long cut slope, to be excavated for the construction of the Sheraton Hotel at Bahria Golf City, Islamabad. The site is underlain by the shale/ claystone interbeded with sandstone of Murree Formation. The field investigations included engineering geological mapping, recording of discontinuity parameters and rock mass evaluation along with necessary laboratory testing. The kinematic analyses have been carried out using computer software DIPS and ROCKPACK III and analytical slope assessment was made using computer program SLOPE/W. The slope was considered stable against the rock slope failure modes; however, SLOPE/W analyses have indicated a global/ rock mass failure under seismic loading and in flooded conditions. Given the height and extent of the cut slope, the economical solution was to modify the geometry of the cut slope, that is, angle and height.

Prediction of uniaxial compressive strength (UCS) of Sakesar Limestone in Salt Range - Pakistan by indirect methods

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Abstract

Intact rock specimens are routinely tested in laboratory for uniaxial compressive strength (UCS) which is an important design parameter in rock engineering. However, laboratory measurement is always expensive, time consuming and is generally not available as part of small projects. Alternatively, indirect tests are relied to estimate UCS of various rocks through developing simple correlations among the results of uniaxial compressive strength (UCS) and indirect tests on the same rock. In the present study, efforts were made to make such correlations for Sakesar Limestone of Central Salt Range. Cored rock specimens were tested for UCS tests, Point Load tests (PLT) and Schmidt Rebound Hammer Tests (SRHT). All the tests' results were analyzed using statistical techniques to find their interrelationships. The developed relations indicated strong correlations between UCS and Point Load Index (PLI), and UCS and Schmidt Rebound number (Rn). From these relations, UCS is predictable from PLT and SRHT with a reasonable precision.

Spatial analysis using geographical information system (GIS) to evaluate areas susceptible to future flash flooding: A case study of Dera Ghazi Khan City, Pakistan

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Abstract

Flash Floods are one of the worst natural disasters; they are dangerous because they are highly unpredictable. Dera Ghazi City experience a devastating flash flood in 2012, as a result lot of damage was recorded. Inspiration of this study came from 2012 flash flood in Dera Ghazi Khan. The purpose of this study is to develop a simple technique by using Geographical information system (GIS) to evaluate areas susceptible to future flash flooding. For this purpose three main parameters soil type, Land use & elevation data of Dera Ghazi Khan City were used. Soil layer was used and it was reclassified according to drainage capability of soil, Land use layer was reclassified according to their runoff potential. Elevation layer was used to generate the percentage slope map of the study area & reclassified into three classes. Three classes of all these parameters were ranked as best (least likely to experience flash flood), moderate, or worst (most likely to experience flash flood).

Reclassified soil, Land use & Elevation layers are combined using GIS spatial analyst, overlay tools. The results of this study showed the area susceptible to future flash flooding & areas that are least dangerous for flash flooding in future.

Folding style within thrust sheet above Decollement: An example from Central Trans-Indus Salt Ranges, Pakistan

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Abstract

Folds are categorized in a single thrust sheet with respect to the Plate Tectonic Transport Direction (PTTD) and three different classes of such folds generated in a single thrust sheet have been observed in the Marwat-Khisor fold-thrust belt constituting the central part of the Trans-Indus Salt ranges. Folds generated towards the hinterland or dorsal side of the (PTTD) is called the trailing edge folds and these folds develop over the footwall ramps and represent the initiation of the tectonic wedge. The Marwat Anticline represents the trailing edge fold towards the dorsal side of the frontal thrust. Folds which occupy the central/middle topography of the thrust sheet are called the intraplate folds and responsible for the major crustal shortening within the thrust sheet. The middle folds zone in the thrust sheet has been observed in central part of the Khisor Range that is responsible for maximum shortening in the cover sequence. The third category of folding is the leading edge folds and the same folds style has been observed in the frontal foothill of the Khisor Range. The frontal fold zone has been eroded and smashed due to propagation of the Khisor frontal thrust wedge. However, remnant parts of the leading edge folds and their unfaulted equivalents can be traced at the lateral termination of the thrust sheet. Majority of folds in various classes possess kink-band geometry. The folds hinges are sharp and their limbs are planar and longer above the basal decollement and make a staircase trajectory with the combination of ramp-flat system instead of concentric or cylindrical folding. The Marwat-Khisor fold-thrust belt provides excellent examples of various classes and styles of folds above the basement rocks/basal detachment horizon in the cover sequence of the Trans-Indus Salt ranges of Pakistan.

Architecture of Fold-Thrust assemblages of the Marwat-Khisor Ranges of the outer Himalayan Orogenic Belt of Pakistan

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Abstract

Marwat-Khisor Ranges as central part of the Trans-Indus Salt ranges of Pakistan describe an east-west to northeast trending fold-thrust belt. This belt depicts the structural style of the southern deformed fold thrust belt of the outer Himalaya that characterizes the mobile perimeters of the Kohat Plateau and Bannu Basin in the south. The prominent fold-thrust assemblages of the Khisor Range are the Paniala, Saiyiduwali, Mir Ali, and Khisor anticlines with a youngest major Khisor fore thrust which bordered the Khisor Range in the south. The Marwat Anticline reveals a macro scale single key structure of the Marwat Range. Fold structures of the Marwat-Khisor ranges are generally asymmetric, overturned and exhibit south facing geometry. Construction of balanced structural sections across this belt suggests that the structural style is thin-skinned and mostly comprised of fold-thrust assemblages. These structural elements are kinematically associated to a regional basal decollement located at the base of Jhelum Group rocks. The Marwat Anticline initially developed as low amplitude forced fold that with the course of time displaced over an unexposed fault ramp to form a fault-bend fold. This episode was followed to the south by another thrust ramp from the basal decollement in the Khisor Range forming fault-bend anticlinal folds in the cover sequence. This ramp-flat trajectory from the basal decollement emerged in the form of Khisor thrust at surface juxtaposing Jhelum Group rocks against the Siwalik Group towards the Punjab Foreland. The Khisor thrust sheet defines the youngest deformation front of the outer Himalayan tectonic wedge in the Trans-Indus ranges.

Sensitivity study of different parameters affecting design of the clay blanket in small earthen dams

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Abstract

Dams are structures that retain water for human services. Dams may be earthen, concrete, timber, steel or masonry made. On the basis of size, they may be small, medium or large dams. The main purpose of a dam is to stop the flow of water for the intended use. Flow of water cannot be stopped permanently even by the best dam ever made. Water may seep from dam body, abutments or the foundation bed below the dam body. To control seepage from the foundation bed, certain available methods like cutoff trench, cutoff walls, diaphragms, grout curtains, sheet pile walls and upstream impervious blankets are used. Upstream impervious blankets are considered more economical comparing with the other methods mentioned above. The key parameters playing role in blanket efficiency are length of blanket, thickness of blanket, clay core width of the dam, foundation bed depth up to impervious zone, reservoir head, permeability of blanket material and permeability of bed material. This study is focused on the effect of these parameters on reduction of seepage quantity. Seep/W, a finite element method based software, is used to model all the mentioned parameters within practical ranges. The results show that when the length of blanket is gradually increased, the seepage quantity reduces gradually until a specific length where the effect of further increase in blanket length is less significant. Same is the case for thickness of blanket but in this case the effect is comparatively less. In case of dam's clay core width, before a certain value, it has almost no effect on seepage reduction. Beyond that value, the seepage starts reducing. When the permeable stratum below the dam body is of more depth, the net seepage is more. The permeability of blanket material and foundation material has same effect on the seepage. When both the materials are more pervious, more seepage will be expected from the dam.

GIS and statistical techniques to evaluate stream sediments and pan concentrate from Peshawar Basin, Pakistan

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Abstract

The utility of GIS techniques are widely employed by geologists for storing, processing and visualizing geochemical data. These techniques together with statistical methods, involving univariate, bivariate and multivariate statistical analysis, play a key role in the field of exploration geochemistry and make the task very easy, thereby, analyzing huge data sets in very short time. The methods were applied to regional geochemical data of Peshawar basin (districts Swabi, Mardan, Nowshera, Charsadda and Peshawar). Samples were collected from stream sediments, panned concentrate and Quaternary deposits. A total number of 92 pan concentrate and 272 stream sediments were analyzed for Au and Ag and base metals such as Cu, Pb, Zn, Ni, Cr, Co and Cd using graphite furnace atomic absorption spectrometer (modal AAS-PEA 700).

The geochemical data of the stream sediments indicated Au is in the range of <0.05 to 11 ppm, Ag: <0.05 to 16 ppm, Cu: <0.02 to 134 ppm, Pb: <0.02 to 54 ppm, Zn: <0.02 to 60 ppm, Ni: <0.02 to 733 ppm, Cr: <0.02 to 202 ppm, Co: <0.02 to 38 ppm, Cd: <0.02 to 11 ppm and Mn: <0.02 to 780 ppm. The geochemical data of the panned concentrates are highly variable. Au is ranging from <0.05 to 45 ppm, Ag from <0.05 to 20 ppm, Cu from <0.03 to 350 ppm, Pb from <0.02 to 203 ppm, Zn ffrom <0.02 to 131 ppm, Ni from <0.02 to 699, Cr from <0.02 to 541, Co <0.02 to 47, Cd from <0.02 to 6 ppm and Mn from <0.02 to 987. The data was analyzed using integrated geostatistical and GIS analysis to look for data dimensions and to delineate target areas for potential exploration. The statistical methods such as histogram, box plot, correlation matrix and factor analysis were performed on data in order to get idea of the elemental distribution and geochemical associations. The percentiles (50^{th}, 75^{th}, 90^{th}, 95^{th} and 99^{th}) integrated with histograms were found useful for distinction between anomalous and background concentration. Geochemical maps were produced in Arc-GIS 10 for panned concentrates and stream sediments by plotting data on topographic maps (1:50,000) and regional geological maps in order to spatially link samples to particular area.

The panned concentrates provide better results for Au, Ag and base metals as compared to stream sediments. The poor geochemical correlation of Au with ore forming elements in both stream sediments and panned concentrates indicated placer origin. The spatial association of Au with River Indus and Kabul also verify this fact. The spatial data analysis was also found useful for base metals association of Cu-Zn in Swabi and Mardan, Pb-Cd in district Nowshera and Ni-Cr-Co-Cu in district Charsadda. It is concluded that spatial data analysis together with statistical analysis are very useful to identify target areas for Au, Ag and base metal in Peshawar basin.

Mapping and analysis of the riparian zone of the Indus River Basin, Pakistan

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Abstract

Riparian zones are one of the fifteen terrestrial biomes of the Earth. Riparian belts are found between land and a river acting as an interface between the two regions. These zones serve important ecological and environmental functions by preventing soil erosion, maintaining habitat biodiversity, creating a bio-filter for pollutant runoff into rivers and reducing flood damage. Riparian buffer zones act as transition areas between land and water which not only create wildlife corridors but also stabilize river banks and control water speed. Water temperature changes are minimized by the shade provided by the riparian vegetation. The vegetation in a riparian zone consists of forest woodland or wetlands mainly characterized by hydrophilic plants. Since riparian zones play a critical role in reducing flood damage and have several other environmental benefits, it is important to analyze the health of riparian belts along the Indus River in Pakistan following the recent floods of 2005 and 2010. The objectives of this research were to (1) analyze quantitatively the health of riparian vegetation, (2) study the wetland condition and (3) channel sinuosity. The research utilized digital image processing techniques to generate land cover maps from Landsat 7 and Landsat 8 imagery of the Indus between 2000 and 2010 and geographic information system (GIS) techniques to quantify the land cover that would fall within the buffer zones. The data was overlayed on topographic data obtained from Vmap to identify the surrounding settlements that could be at a greater risk of flood inundation in the absence of a healthy riparian belt.

Determination of ground water potential in Mirpur, Bhimber area of Azad Jammu and Kashmir by using geoelectric method

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Abstract

Present study is an attempt to determine ground water potential in various districts of Azad Jammu and Kashmir by using geoelectric method. The electrical resistivity sounding (ERS) was carried out at Mirpur and the surroundings. The ERS station includes Barnala, Barala Chappar, Maira Jatta, Hemelwala, Qilla Chpper, Saryaala Chpper, Pangali, Barmala Cham, Awan Shareef, Salyaanwala and Galorta area. During present work, different characteristics like transmissitivity (T), storativity (S), hydraulic conductivity (K) and estimated theoretical discharge (Q) were studied. The parameters deduced have been used to make quantitative and qualitative interpretation.

As a part of processing and interpretation of data, computer software, ipi2win was used for interpretation of VES curves. Quantitative interpretation was based on vertical lithological columns. The interpretation in term of hydrogeological characteristics of aquifers was also carried out to measure aquifer thickness and correlation, transmissitivity, hydraulic conductivity and theoretical discharge. The results were discussed in context with installation of dug wells and tube wells. The results indicated that the area is mostly composed of clay, gravel, pebbles and boulders. This composition is indicative of alluvium or quaternary deposits with unconfined and leaky aquifers.

Resistivity studies have been proved to be very helpful in plotting the strata and underlying bodies of water. The source of water is satisfactory for drinking and other domestic purposes. It is recommended that at least one test well/bore hole up to 10m depth should be drilled in the area in order to verify the lithology for findings of present study.

Historical records of snow avalanche events as guidance for preventive spatial planning: Case study of Washich Village, Tehsil Torkho, District Chitral, Khyber Pukhtunkhwa

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Abstract

Snow avalanche is an important and very active geomorphic process in high mountains, and are one of the most important natural hazards which acting on the mountain environment, cause each year several fatalities and burials/injuries. Experts on the subject cannot predict, nor do they completely understand each and every avalanche occurrence. The slope failure associated with an avalanche is caused by several factors, but primarily by large accumulation of snow on a steep slope. If it is too small, the component gravity force along too gentle slope is not strong enough to initiate an avalanche. On the other hand, on too steep slopes, big lasting deposition is not possible and so a coherent snow mass does not occur here. Avalanches occur on slopes averaging 25^0 and 55^0, and the majority is on slopes between 30^0 and 40^0 like in the Washich village, Chitral District. They are triggered by natural, seismic or climatic factors such as earthquakes, thermal changes, and blizzards, and by human activities.

Pakistan has a history of tragic events of snow avalanches. Average fatalities of 39/year reported from 2005-2014 (FOCUS internal data) which also justified that Pakistan is one of the highest vulnerable country in regards to avalanche hazard. Avalanches cannot be considered as a problem limited mainly to local inhabitants of mountainous areas or to their properties and infrastructures. They often affect tourists/sportsmen coming from other regions and countries. It is impossible to determine how many avalanches of all sizes occur in northern part of Pakistan but Washich is one of the most snow avalanche hazard prone villages in District Chitral, KPK. Small avalanches occur throughout the winter and spring, however, in 2007, 42 causalities were occurred due to an unexpected single avalanche event in early spring season. The most common types of avalanches in Washich village are loose-snow, wet and slab avalanches which are responsible for damages of households, infrastructures etc.

Spatial planning is a key instrument for reducing the vulnerability of society against natural hazards, but its potential is yet to be fully utilized. Systematic use of historical data and local knowledge on natural hazards, seems to be one pre-requisite for improvement.

It is recommended that local administrative units like UC activate local knowledge on historical natural hazards events and implement these insights in land use planning. This could be done by appointing a group with mandate to establish a database of natural hazards events, potentially stimulating community commitment to hazard prevention. Systematizing of professional reports, archive inquiries and interviews with elderly people would be appropriate methods. Interpretation of historical information needs to be assisted by geological expertise, and should be a supplement to expert's investigation.

Lithological correlation of the Miocene succession over 20,000 km^2 of Indus Offshore, Pakistan

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Abstract

Offshore area of Pakistan consists of two different geological provinces: the Indus Offshore Basin, and the Makran Offshore Basin. The Indus Offshore Basin reflects sedimentation associated with Mesozoic rifting of the Pakistan-Indian margin, superimposed by a terrigenous clastic depositional system comprised of deltas, shelves, and deep-sea fans of the Indus River. Sea level changes and the Himalayan Orogeny have profoundly affected the Indus Fan sedimentation since the Oligocene-early Miocene age.

The study area lies geographically between latitudes 23.25° to 24.5° N and longitudes 66.50° to 67.50° E. The area is spread approximately over 20,000 square kilometer. Seismic reflection method such as acoustic impedance, interval velocities and geophysical relationship were used for lithological characterization of the Miocene succession in the study area.

Based on the above analysis it is concluded that the area is structurally less complex and comprises mostly of gently sloping depositional layers of interbedded shale and sandstone.

The results of reflection coefficient and acoustic impedance shows the lithology of the Miocene succession was interpreted as shale on south-west region, due to low reflection coefficient (seismic lines 86-9013, 86-9029, 86-9052, 86-9068, 86-9033) and as porous sandstone on slope fan region (under seismic line 86-9072). The results were verified from well data located in the studied area. Lithologies were confirmed from the correlation of gamma ray and porosity log. From the interpretation of well log, dominant lithologies are sandstone, shales and their intercalation. These values lie in the standard range.

Physico-chemical and microbial studies of the drinking water of union council Gandheri, District Nowshera, Khyber Pakhtunkhwa, Pakistan

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Abstract

The present study investigates hydrochemical and microbial concentrations in the drinking water of selected villages in the Union Council Gandheri, district Nowshera, located in the Peshawar Basin. A total of 49 drinking water samples were collected from Thordher, Behram Kally, Chehel Banda and Kalinger areas of District Nowshera using standard procedures. These samples were analyzed for physico-chemical (pH, alkalinity, total dissolved solids, F, Na, K, Ca, Mg, As, Cl, HCO_3, CO_3, NO_3, SO_4) and biological parameters (total colliform, fecal colliform, E-colliform) using standard procedures. Among these, the nitrates (0.5-35 ppm) and flouride (0.37-7.9 ppm) exceed the permissible limits set by WHO. Similarly the turbidity (0.2-755 NTU) in 16 samples and total dissolved salts (239-1380 ppm) in 4 samples have anomalous concentrations. The rest of the physico-chemcial parameters are within the permissible limits of WHO standards. Moreover, the higher concentrations of fecal colliform up to 130 MPN/100 ml and total coliform up to 900 MPN/100 ml with positive E-Colliform, in most of the studied samples, confirm microbial contamination in drinking water sources of the area.

The elevated concentrations of fluoride, nitrates, dissolved salts, and microbes is causing serious health hazards as indicated by the occurrence of dental fluorosis, joint pain, dysentery, diarrhea and various other water borne diseases among the inhabitants of the study area in general and the children in particular. The presence of fluoride containing minerals and finer sediments, in lacustrine and alluvial deposits of the study area, are considered to be the main contributors of fluoride and tubidity in groundwater sources. High amount of nitrates may have been contributed from the fertilizers, human and animal wastes.

It is, therefore, suggested that the supply of clean drinking water may be ensured on urgent basis for the eradication or control of various water related health hazards in the studied villages. Further more the inhabitants of the area needs to be properly educated through various trainings for the sustainable utilization of drinking water resources.

Temporal analysis of the spatial extent of hispar glacier using TRMM and LST data

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Abstract

The largest glaciers, besides the Polar Regions, are found in the Northern Asian mountain ranges of Pamir, Karakoram and Himalaya. The runoff from these glaciers feeds into Indus River in Pakistan which is the largest source of water supply for the entire country. The glaciers are sensitive to climate change and their spatial extent keeps fluctuating based on the climate conditions and topography. Satellite imagery indicates that there may be large spatial variations in the glaciers due to topography and climate dynamic. In order to quantitatively assess the relation of glacial extent with climatic factors, Hispar Glacier was selected as the area of study. Found in the Karakorum Mountains, Hispar Glacier is a 49 km long glacier which connects with the Biafo Glacier (63 km) at Hispar La Pass to create the longest glacial system in the world (besides Polar Regions). The area of interest was delineated from Landsat 8 image using ASTER DEM of 30 meter resolution. Three toolboxes, (1) Glacier Mapping Toolbox, (2) TRMM data processing Toolbox and (3) LST data processing Toolbox, containing a total of thirteen tools were created for the analysis. TRMM (Tropical Rainfall Mapping Mission) and MODIS Land Surface Temperature (LST) data between the period of 1998 and 2014 were used to examine temperature and precipitation patterns and compared with the glacial extent for different time period analyses.

Geoseismic modelling of anticlinal structures of Sakhi Sarwar, Drigri and Kotrum in the south of Zindapir area of Sulaiman Fold Belt with the help of seismic reflection data

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Abstract

These anticlines lie in the south of Zindapir anticline, a part of Safed Koh trend (N-S trending), which is a first line of folding on the folded flank of Sub-Sulaiman Foredeep. In the East of area, Punjab Monocline is present and Sulaiman Fold and Thrust belt is present in west. This area is a Frontal fault propagation folded zone. Research area lies in south of Safed Koh trend, Central Indus Basin. Seismic lines are interpreted to get stratigraphical and structural information of subsurface. The general stratigraphic successions are marked on lines 954-FZP-06 (south of 976-FZP-06) and LMT95-09 with the help of well Sakhi Sarwar-01. Seismic line 976-FZP-06 lies in Fazilpur area that shows Sakhi Sarwar anticline with a flower structure present in the core suggesting wrenching along with compression. Time contouring maps of Paleocene, Eocene and Oligocene show the formations are getting shallow in east. Seismic profiles 914-RPR-03 (34 Km) and 914-RPR-05, (26 Km) lie in NW of Rajanpur area of District D.G.Khan. Reflectors are marked & correlated with the help of wells Drigri-01 and Kotrum-01, located near line 914-RPR-03 and 914-RPR-05 respectively. Depth sections of Drigri and Kotrum anticlines are prepared. These structures lie in the SE of Sakhi Sarwar anticline. Folding is prominent in reflectors. Drigri anticline has E-W trend over 17 Km approximatly and the reverse Faults are present on both flanks of a fold. Whereas the cross section of Kotrum anticline shows the amplitude of fold is low suggesting that folding die out at the Southern part. Trend of the fold is NE-SW. Depth sections show that a thickness of sedimentary cover is 8 Km approx. Thickness of Nagri Formation and Chinji Formation (Miocene- Pliocene) is 1700 m approx. Nari Formation (Oligocene) is overlain by Gaj (Vehowa) Formation in the area. Eocene & Paleocene are 1300 m & 800 m thick respectively. Basement is uplifted in the east.

Effect of variation in rainfall on vegetation in Thar and Cholistan desert, Pakistan: A GIS perspective

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Abstract

The Thar and Cholistan desert of Pakistan is a drought prone area due to poor and delayed monsoon, abnormally high summer-temperature and insufficient water resources. This research is a comprehensive evaluation and integrated analysis of drought, which has been carried out by using satellite based remote sensing and GIS techniques. The objective of this research was to standardize, by time of year, the Normalized Difference Vegetation Index (NDVI) to assess the vegetation changes or positional shift of green belt at Thar and Cholistan. The study was conducted with 9 years (2003-2012) of ten days maximum composite of NDVI images from SPOT and precipitation images from TRMM were used as an input. NDVI distribution is used to estimate the probability of occurrence of the present vegetation condition at a given location relative to the possible range of vegetative vigor, historically. Reliance on weather data alone is not sufficient to monitor areas of drought, particularly when these data can be untimely, sparse and incomplete. Augmenting satellite images (SPOT vegetation) with the weather data (TRMM) to identify the location and severity of droughts is a must for complete, up-to-date, and comprehensive coverage of drought conditions. For doing so, the vegetation changes or the positional shift of the green belt were most accurately identified by using the vectorize form of NDVI and TRMM in DSAS. The Digital Shoreline Analysis System (DSAS) calculates the positional change of the green belt over time at this region and revealed that vegetation growth was controlled by rainfall and vegetation indices could reflect the temporal and spatial variability of moisture conditions.

Effect of precipitation on discharge level in barrages in Pakistan

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Abstract

Floods have been one of the major natural hazards in Pakistan. In the last decade alone Pakistan was hit by floods in 2005, 2010 and 2011. These resulted in enormous loss of human lives, damages to infrastructure and deterioration of the economic conditions prevailing in the country. Climatic conditions have become uncertain due to weather pattern changes resulting in amplified glacial melting and unusual heavy rainfall. Discharge from barrages too plays a significant role in increasing the extent of flood damages. As barrages have a limited storage capacity and when a certain threshold capacity is attained it is forced to discharge the excess amount of water which adds to the outflow of flood water.

This study aims to use daily discharge records for the last three years from 2010 to 2013 and TRMM datasets for the respective dates. As it is known that most of the discharge in Pakistan is affected by the rainfall along the stretches of northern Humid belt Khyber and Lahore disticts we aim to calculate the stress coefficient that individual barrages were bound to face. The process shall be independant of conventional methodologies and would specifically address the use of open-source GIS software in identifying the extent to which individual barrages are affected in case of unprecedented rainfall.

Microfacies analysis and reservoir potential of the Eocene Chorgali Formation, Chorgali Pass section, Gali Jagir, Punjab, Pakistan

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Abstract

The Eocene Chorgali Formation is exposed in the Chorgali Pass Section, Khair-e-Murat Range, Punjab, Pakistan. A section of the formation in the Gali Jagir Village is measured, logged and sampled for the recognition of textural constituents and reservoir assessment. The formation is approximately 62.5 m thick having both lower and upper contacts with the Kuldana Formation but the lower contact is faulted while the upper contact is normal conformable. The outcrop section consists of limestone, dolomite having algal laminations, shale and marls.

Five microfacies are recognized on the basis of relative visual estimated ratio of allochems and micrite. These microfacies include: 1) Algal laminated Mudstone, 2) Non-laminated Mudstone, 3) Dolomitized Mudstone, 4) Wackestone, and 5) Siliciclastic Mudstone. The microfacies interpretation, scarcity of carbonate grains, presence of abundant carbonate mud, algal laminations and dolomite reveals that the Chorgali Formation shows deposition in tidal settings.

The Chorgali Formation is also modified by various diagenetic processes including micritization, dolomitization, microfractures, stylolitization, dissolution, neomorphism, spar-filled fractures and iron minerals cementation. The different porosity types recognized are intracrystalline/intraparticle, intercrystalline, moldic, vuggy, fenestral and fracture porosity. The visually estimated average microporosity of this outcrop section is 2.21 %. The dominant factor which adds to the porosity and permeability of the Chorgali Formation is fracturing which is evident on the outcrop as well as microscopic-scale.

Flood hazard assessment using GIS/RS tools: A case study of Lower River Swat Basin, NW (Pakistan)

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Abstract

Flooding is the most frequent and devastating phenomena around the globe. With the rapid growth in population and relative disturbances in the natural ecosystem lead to global climatic changes and by these alterations natural hazards such as floods, earthquake, mass wasting and cyclone are tremendously increased. Heavy precipitation in monsoon season especially in south Asian countries like India, Bangladesh and Pakistan coupling with melting of snow generates high surface runoff resulting in overflow in the river channels. This overflow in the river body ravages the downstream areas, and caused damages to both life and property. Due to the frequent flooding and its destruction to the human society in Pakistan, the demand for flood hazard assessment using Geographical Information System (GIS) and remote sensing has increased. The scope of the present study is to model the Lower River Swat channel of district Swat having the length of 6 km from upstream Sangota to downstream Ayube Bridge by the integration of field data, Hydrodynamic Model (HEC-RAS), ASTER DEM and GIS. GIS and HEC-GeoRAS technology has been used for the geospatial analysis of the study by using the ASTER DEM (30 m). The river geometry data which is main input to HEC-RAS was obtained through by field survey with help of total station (Sokkia, Model No= CX105, made in Japan). HEC-RAS has been used for the simulation of the hydrological data. The HEC-RAS model was calibrated through by known water discharge (4971 m^3/s) for the peak flood year of 2010 with the support of Manning's 'n' values and contraction and expansion of the river channel. The results were slightly higher for some of the cross-sections but in comparison to overall the model results show an average difference of 0.36 m which is in the acceptable limits. To check out the model validity to that of known water surface (HFL) for the peak flood of 2010, a correlation curve was developed. The output of the curve indicate best correlation (R^2= 0.99) to that of model computed water surface level. However post- processing in the GIS environment was not possible due to the low resolution of ASTER DEM. Further the study suggested that the integration of GIS, RS (ASTER DEM) and Hydrodynamic model (HEC-RAS) play a vital role in predicting of future floods and its spatial inundation in the nearby floodplains.

Glaciotectonic structure and origin of Badswat glacier moraine

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Abstract

The lithology and Glaciotectonic structures studies are carried out on Badswat glacier moraine to evaluate its origin. The Badswat glacier moraine runs through center of valley and develops in result of ice movement from north to south. The first look of moraine gives impression of medial moraine but vegetation and western dipping of moraine confirms as lateral moraine. The reconnaissance survey of Badswat glacier allows to divide moraine in three segments: a. Segment starts from junction of glacier and its distributary and twists towards eastern slope of Valley and minimize the width of glaciers; b. concave segment begins from displacement of moraine to south of present snout of glacier; c. segment changes shape from concave to straight. The concave segment illustrates cycle of retreat and advancing despite decrease in mass balance of glaciers. The presence of concave little moraine at snout demonstrates advance of glacier before start of present retreat. Whereas, structure at end of segment "a" has influence on movement of glaciers for example thick cover debris block the movement of glaciers which reflects on mass balance of glacier at segment "b". However, present mass balance is decreased due to climate change or neotectonic process in the area. The glaciotectonic structures on eastern slope of valley indicate glacier activity mainly along eastern slope. The sedimentation section of Badswat Glacier area is simple glaciotectonic sediments and less deformed. However, glaciotectonic process develops on eastern flank. The boulder layer on the coarse sediments is tabular deposition. The sediments of moraine are less deformed but consolidate by push of ice. The boulder deposit layer on coarse sand and pebbles demonstrate maximum height of glacier during glaciation period. The absence of end moraines at Badswat glaciers shows retreating of glacier. The supraponds causes mudflow/ floods in Badswat Catchment area. The detail study of glaciofluvial sediments and structures with deterring of age of sediments will help to develop model of climate change and its impact on advance and retreat scenario of Badswat Glacier.

Application of earthquake perceptibility hazard to Pakistan

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Abstract

Earthquake hazard statistics are of significant interest to earthquake engineers designing civilian or critical structures, allowing them to withstand earthquakes and their resulting ground motions. Anti-seismic design criteria can benefit from a range of earthquake metrics generated from the maximum earthquake potential of any seismically-active region. For example, peak or spectral ground motions, maximum magnitude recurrence of cumulative seismic moment release statistics all have their place in modern seismic hazard and risk forecasting techniques as well as anti-seismic design.

Earthquake perceptibility theory is a metric that may also be adopted in the standard remit of any seismic hazard assessment. This constitutes a specific measure of earthquake hazard useful to seismic engineers in isolation or alongside other earthquake metrics. This technique yields a specific *design* earthquake that can play a role in building collapse, economic loss, building usability and anti-seismic design in non-critical structures, and has been adopted to assess seismic hazard across parts of Europe since the late 1970s. Even so, it is often overlooked in favour of more common, better-understood *whole-process* or *part-process* models on which earthquake perceptibility theory is reliant. However, it has not until now been advocated as a viable option to assessing seismic hazard across Pakistan.

Earthquake perceptibility is defined as the probability a site perceives ground shaking equal to or greater than a selected ground motion level, X, resulting from an earthquake of magnitude M, such that:

$$P(X \mid M) = P_c(X)\, P_e(M)$$

$P_c(X)$ estimates the probability of perceiving ground motion level X from an earthquake of magnitude, M. $P_c(X)$ will increase at a non-linear rate with respect to M and can be considered as a ratio of the felt area at X to that of the considered area. $P_e(M)$ will be the derivative – probability density – of the specific statistical earthquake recurrence model, beit of *whole-process* or *part-process* in form. Perceptibility hazard at discrete levels of ground motion is examined under constraints of earthquake perceptibility in such a way that hazard is partitioned at discreet, pre-selected magnitude intervals.

Earthquake perceptibility hazard is best expressed in the form of contoured hazard maps across local and regional extents, or using earthquake perceptibility curves for site-specific scenarios. The peak of a perceptibility curve is given by:

$$\mathrm{d}P[(\mathrm{X} \mid M)] / \mathrm{d}M = 0$$

This therefore defines the magnitude considered the *most perceptible earthquake* and constitutes a characteristic earthquake property for a region due to its dependence on regional attenuation of the felt ground motion considered and the seismicity properties of the area.

A new assessment of earthquake perceptibility hazard is therefore proposed and planned with colleagues from the National Centre of Excellence in Geology, University of Peshawar. This will supplement current work on extreme magnitude recurrence seismic hazard across Pakistan and its surrounding region. This new work will consider perceptibility hazard with respect to ground acceleration, velocity and macroseismic intensity at a range of geographic resolutions. For purposes of this presentation however, a comparable example is given of an earthquake perceptibility hazard assessment across the south-eastern Balkan extent.

Arsenic and fluoride bioaccumulation in vegetables through water and soil: A toxicological risk assessment study

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Abstract

The current study was estimated simultaneously arsenic (As) and fluoride (F^-) concentration in surface water, soil and vegetables in Nagarparkar, Pakistan during 2010-2012 and their risk assessments to human health. Total As and F^- concentration in surface water samples were found in the range of 350 to 683 µg/L and 20.1 to 31.7 mg/L while As and F^- concentrations in soil samples were ranged 110 to 266 and 90.4 to 518 mg/kg, respectively. The high concentration of As and F^- was observed in wild cucumis as compared to Indian squish and cluster bean, indicates the elevated accumulation of As and F^- form growing media. The estimated daily intake and hazardous index of vegetables according to age group as: 7-15 years > 16-25 years > 26-50 years. These finding elucidated that the population consuming local vegetables and drinking water were at the risk of severe chronic toxicity of As and F^-.

Geological mapping with special emphasis on landslides hazard analysis from Gharri Dopatta to Hatian Area, Azad Kashmir, Pakistan

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Abstract

The Study was carried out to prepare a geological map of the area in detail, and to understand landslide problems in the area. The Saran landslide was studied in detail due to its large size, proximity to road, public and government infrastructure and presence of Muzaffarabad Fault in the landslide area. Other than Muzaffarabad Fault, heavy rain fall, steep slopes and alternative beds of sandstone, shale and clay as well as a road widening project, all contribute to landslides in the area. Rock Falls and Rock slides are common in the area as well.

Samples were collected from the Saran landslide to evaluate the engineering properties of soil. In the laboratory different Soil tests were conducted, including evaluation of natural moisture content, Sieve analysis, Plastic and Liquid limit test, Compaction test and Specific gravity test. According to prevailing conditions of soil, different suggestions were made to improve the land sliding conditions in Project area.

Geochemistry, economic geology and health hazard assessment of the phosphate deposits of Paswal Mian and surrounding areas, District Abbottabad, Khyber Pakhtunkhwa, Pakistan

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Abstract

Pakistan is a leading agricultural country and almost 70% of its population is dependent directly on agriculture practices. Phosphorous is vital for plants growth and yield. Besides a number of other sources phosphorous commonly occurs in phosphate deposits. Phosphate bearing rocks are present in different horizons including Precambrian-Cambrian, Late Jurassic-Early Cretaceous, Paleocene, Eocene and Oligocene. In Pakistan most of the economical phosphate deposits occur in the Cambrian rocks of Hazara. These deposits are present in the upper part of Abbottabad Formation of Cambrian age and are widely distributed in Hazara region and extended up to Kashmir. In the study area, the phosphate rock generally occurs in association with dolomite of Abbottabad Formation in the form of thin lenses but sometime it bulges up to several feet and occurs 30-40 feet above the quartzite member.

The representative samples were collected from the phosphate beds exposed in three localities (i.e, Paswal Mian, Banseri and Shakot) in Abbottabad District. These samples were analyzed for major and trace elements using Atomic absorption spectrometer and UV/VIS spectrophotometer in the Geochemistry Laboratory of the National Centre of Excellence in Geology, University of Peshawar. The major element oxides are highly variable. SiO_2 is in the range of 7.35-57.35 wt%, Al_2O_3: 0.52-6.2wt%, TiO_2: 0.01-0.25wt%, Fe_2O_3: 0.23-2.11wt%, MnO: 0.01-0.11wt%, MgO: 0.04-15.01wt%, CaO: 18.77-60.17wt%, Na_2O: 0.18-0.62 wt%, K_2O: 0.02-0.30 wt% and P_2O_5: 1-25 wt%. Among the trace and heavy metals, Cu varies from 1.05-13.25ppm, Cr from 6.64-27.5ppm, Ni from 1.25-44.5ppm, Zn from 11.95-269.35ppm, Co from 0.05-10.4ppm, Pb from 17.9-209ppm and Cd from 0.65-5.3ppm.

Geochemically, the phosphate rocks of the study area are having economic concentration of P_2O_5 with the required major oxides which can be utilized in the manufacturing of fertilizer. The concentration of heavy and trace elements are also within the safe limits of WHO and will, therefore, not pose any kind of environmental problems if used in fertilizer for agriculture purposes. This preliminary study on the studied phosphate rocks is indicative of occurrence of other phosphate deposits of similar types in the region. Therefore, further detailed study in the region is suggested.

Shale gas potential of Sembar and Goru Formations in Lower Indus Basin, Pakistan

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Abstract

In this paper Shale-Gas potential of the Sembar and Goru shales are investigated in the Lasbella area of Balochistan and the sub-surface study of the Badin block. The outcrop samples of the potential shale-gas intervals were analyzed for the detailed petrographic, geochemical and textural study. The XRF results indicate that the Ca, Si, O, Al occurs in high concentration, while the XRD findings confirmed the presence of quartz, calcite, albite and clinochlore minerals. The petrographic study suggests that the quartz grains are sub-angular to sub-round and fractured while calcite is also present. The interparticle and intergranular porosity ranges 10 to 20 %. The pores are uniform in size. A high porosity is noted along the fractured zone of the quartz grains. The SEM and EDS findings revealed that matrix and cementing material are calcite and silica while subordinate feldspar, dolomite and the heavy metals (iron and tantalums) are also present. Based on the depth and gross thickness of the Semabr and Guru shales in the subsurface from the Badin block, an isopach map is drawn. The geochemical analysis of the Sembar-Guru shales confirmed a high TOC values, ranging from 0.5-3.5%, presence of Kerogen type II and type III, thermally mature (Early mature < 0.50 percent Ro, to mature >1.20 percent Ro) nature of the rock. These geochemical attributes are generally considered to be favourable for the shale gas extraction. The overall result indicate the existence of the numerous shale-gas horizons having favourable depth, a significant thickness, suitable kerogen type, maturity index and TOC values in the Sembar and Guru Formations, which can yield large volume of shale gas.

The depositional setting of the late Quaternary sedimentary fill in an intermontane basin, Northwest Himalayan fold and thrust belt, Pakistan

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Abstract

Pakistan is a country with moderate to high seismicity, as it is situated at the junction of the world's three great mountain ranges: The Himalaya, The Hindu Kush and the Karakoram. So the severity of seismic hazards of major seismic events is not ignorable. The focal mechanism solution and spatial distributions of major earthquakes of local magnitude > 4.5, that have occurred in lesser and central Himalaya mostly in northern and central part of Pakistan in the last fifty years, are examined and discussed. The earthquake data of three international catalogues is used along with computer based algorithms. The spatial distribution of their epicenters as a function of depth shows that most of the earthquakes are of shallow to intermediate depths. The relationship between major faults and their source mechanism is also investigated. The majority of the focal plane solutions in the study area show strike-slip faulting with a left-lateral sense of motion, followed by thrust faulting along with some normal faulting. The subduction of the Indian plate under the Eurosian Plate is a source of some of the major events with thrusting and reverse faulting. These low-to-intermediate angled thrust faulting is dominant to a depth of 40 – 70 km. This suggests that the Indian plate is moving with respect to the Eurasian plate along the Chaman fault, Quetta Transverse Zone, the Suleiman Ranges and the Hazara thrusts region joining the Hazara/Kashmir syntaxis. It is seen that in a large number of events the compressive stress is acting nearly in NNW-SSE to N-S directions. For deeper events, focal mechanism solutions are mostly characterized by down-dip compression in both lesser and upper Himalaya.

Structural analysis and geological mapping of Jhanda, Sehrmandi, Nar and Sathan Nakka areas, Southern Hazara Kashmir Syntaxis, district Kotli, Azad Jammu and Kashmir, Pakistan

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Abstract

The study area lies in the Southern Hazara Kashmir Syntaxis. The Hazara Kashmir Syntaxis in an antiformal structure formed due to the Himalayan orogeny. The Tertiary molasse sequence lies in the core of the syntaxis, formed due to the uplift, erosion and deposition in the Himalayan Foreland Basin.

The molasse sequence is folded and imbricated due to late Tertiary Himalayan collision. The folds are southwest or northeast vergent and faults are southwest directed. The folds have northwest southeast trend, northeast or southwest vergence, northeast or southwest dipping axial planes, open fold geometry and northwest or southeast plunge.

The faults in the area are reverse and normal in nature. The northwest southeast trending fold-and-thrust belt in the area is the result of northeast or southwest Himalayan compression. However, the normal faulting represents the late Himalayan extension in the area.

The Paleocene-Eocene fossiliferous limestone-shale sequence in the core of these anticlines can provide the source and reservoir rocks for oil and gas generation and accumulation. However, the clays of the Kuldana, lower Murree and Chinji Formations are the best seal rocks for these structural traps. The Fagosh and Nar Anticlines represent the structural traps for oil and gas exploration.

Wheat yield estimation using temporal NDVI for the district Sheikhupura, Punjab, Pakistan

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Abstract

Agriculture constitutes the largest sector of Pakistan. Punjab is most agricultural province and produces wheat, cotton and other crops and plays an important role in national economy. Sustainability of the wheat production leads a populous region toward self sufficient. To monitor and manage our natural resources using efficient means is ultimate goal and remote sensing techniques provide better observation over the larger areas. Leaf area index, above-ground biomass and vegetation cover are generally assessed using normalized differenced vegetation index.

This paper also designed on NDVI basses and provides the utility of NDVI for the yield estimation in the Sheikhupura district. For this purpose six images from the sensors including Landsat, TM (2009-2011), ETM+ (2012) and Landsat-8 OLI (2013-2014) are selected. All selected images were of dated mid of March keeping in view the health crop of wheat in this period. NDVI from all the six images are derived and healthy crop area are extracted. Area of the healthy crop is calculated and compared with the wheat yield declared by bureau of statistics Punjab. Linear regression approach for estimation of yield of wheat crop is used

Predicted value of wheat production in district Sheikhupura for the year 2014 is estimated by using NDVI techniques. It is found that there was change in the area calculated by NDVI values showing healthy crop in temporal images from secondary data. This could be an important technique in crop area estimation and yield prediction at larger spatial scale. Sustainable management at district level is manageable if we use latest RS and GIS techniques to help out societal resources. RS and GIS help to find land use change using these it is easy to meet the challenge of developing countries to manage and increase food resources for the high growth population. This can help to strengthen the existing institutional capacity.

Structural evolution of southern Kohat Fold & Thrust belt, Karak area, Pakistan

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Abstract

Structural evolution of Southern Kohat Fold and Thrust Belt is interpreted through a structural model and two geo-seismic balanced cross sections prepared by integrating dip domain data, seismic data of 96-SHD-313 and well bore data of Makori East 1. The model and sections reveal the subsurface geometries of folds and thrusts and variation of structural style along trend in relation to fold and thrust kinematics. Samana Suk Formation of Jurassic age is taken in subsurface seismic data for which time to depth conversion is done and the values are extrapolated to cross sections. The geo seismic balanced cross section shows that the thrust faults emanating from basal detachment located at sedimentary crystalline interface become steeper up section as indicated by bedding attitude at surface along thrust traces. The tight anticlinal and broad synclinal folded structures evolved on Eocene evaporites as detachment folds were truncated by thrust faults along their limbs at surface which relates that folds formed earlier than faults. The structural models show that variation of surface structures along the trend is proved to be the result of variable displacement of thrusts along their strike. The restored sections show approximately 7-8 Km of shortening accommodated by deformational structures. This research suggested that the Southern Kohat Fold and Thrust belt is structurally evolved in two distinct stages of deformation along the multiple detachment horizons. In the first phase detachment folding along Eocene evaporites had accommodated the shortening which is superimposed by thrusting emanating from basal detachment.

Reservoir characterization and sequence stratigraphic interpretation of well log data of Turkwal Deep-01, Eastern Potwar, Punjab, Pakistan

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Abstract

The rock units drilled in the Turkwal Deep-01, Eastern Potwar, are investigated in terms of sequence stratigraphy and reservoir characterization using well logs. The well data was provided by Land Mark Resources with the approval of Directorate General of Petroleum Concessions (DGPC). Total depth of Turkwal deep-01 is 4300 m. The drilled rock units range in age from Pleistocene to Pre- Cambrian. Various petrophysical parameters were calculated for each rock unit. Based on these parameters, the Chorgalli Formation is turn out to be possible major reservoir while the Sakessar, Lockart, Warchha and Dandot Formations are the minor characteristics of a reservoir.

Two log intervals are marked in the Turkwal Deep-01, one comprising of the Jhelum Group while other is the Nilawahan Group. Based on log and published literature data different environment of deposition are assign to the different rock units. The Khewra sandstone has facies ranges from shallow marine, transitional (deltaic) and terrestrial facies indicating a regression phase of sea level. The Kussak Formation is deposited in marginal marine to shallow marine environment indicating a transgression of sea level. The Jutana Formation in again showing another episode of regression, while its facie are documented as shallow marine, followed by subtidal then intertidal and some supratidal facies are presents.

The Tobra Formation which contains glacial facies and showing a fall in the sea level. The Dandot Formation again record a rise in sea level as its facies are ranging from marginal marine to shallow marine environment. The Dandot Formation is followed by terrestrial fluvial sediments of the Warchha Formation which again marks a prominent fall in the sea level, while upward the Sardhai Formation record transitional to restricted environment (Lagoon) facies which were deposited in the transgression phase.

Lithostructural insights into Khairabad Area to evaluate its economic potential, Western Salt Range, Pakistan

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Abstract

This study attempts to address the structural evolution and stratigraphic setup of a part of the Western Salt Range. The area being located at the confluence of Salt Range Thrust (SRT) and Kalabagh Fault (KF) is therefore exposed to transpressional stresses. The exposed rocks range from the Late Permian Chiddru Formation to the Holocene Kalabagh Conglomerates with few unconformities. The NW-SE trending and southwest facing Khairabad Anticline is the major overturned fold of the area. A mappable NW-SE trending thrust fault is present in the northwestern part. The NW-SE tectonic transport direction shows that the influence of the movement along the oblique ramp of the SRT overprints the effects of strike slip movements associated with KF. The mesoscopic extensional structures (normal faults, horst and graben structures) present in the northeastern half of the mapped area reflect the active salt tectonics.

The excellent and well preserved source, reservoir and seal rocks make this area to be a probable hydrocarbon prospect. A number of economic minerals like gypsum, celestite and various clay deposits add to the economic importance of the area.

Integrated biostratigraphy and depositional environment of the Patala and Nammal Formations, Western Salt Range, Pakistan

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Abstract

The biostratigraphy and depositional environment of the Patala and Nammal formations are reported from the western Salt Range. The identified age diagnostic planktic foraminiferal species include *G. pseudomenardii, A. sibaiyaensis, P. wilcoxensis. M. acuta, M. subbotinae, G. luxorensis, Parasubbotina varianta, A. velascoensis* and *Subbotinae* sp.. The larger benthic foraminiferal assemblage include *M. miscella, M. dukhani, M. meandrinus, R. sindensis, Glomalveolina* sp., *Operculina heberti, Orthophragmina* sp., *Assilina yvettae, Lockhartia* sp., *Ranikothalia sindensis, A. dandotica, D. dispansa, D. sella, D. ranikotensis, Orbitoclypeus* sp. and *Nummulites* sp.. The biostratigraphic range of the planktic forminifera is from P4-E2 and the larger foraminifera is from SBZ4-SBZ8. These biostratigraphic zones suggests that the deposition of the Patala and Nammal formations took place during the time period of 54.5 to 56 Ma which is equivalent to the latest Thanetian-earliest Ypresian ages. The following microfacies are encountered in Patala and Nammal formations of the western Salt Range; 1. Nummulitids- grainstone microfacies, 2. Nummulitids-orthophragminids packstone microfacies), 3. Wackestone microfacies (Pelagic foraminiferal wackestone submicrofacies and Bioclastic-molluscs wackestone submicrofacies), 4. Mudstone microfacies (Partially dolomatized mudstone submicrofacies and bioclastic- pelagic foraminiferal mudstone submicrofacies) and 5. Wacke-packstone microfacies (nummulitids-orthophragminids wacke-packstone submicrofacies, Pelagic foraminiferal wacke-packstone submicrofacies and Foraminiferal bioclastic wacke-packstone submicorfacies). Based on these microfacies the depositional environments of the Patala and Nammal formations are interpreted to represent the inner, middle and outer shelf marine environments. According to Haq et al. (1987), the global sea level curve represent rising on a long term scale however, on a short term scale a sea level fall followed by a rise is documented during the time period of the deposition of Patala and Nammal formations. This short term sea level fluctuations is also observed in the Patala and Nammal formations of the western Salt Range, Pakistan.

Microfacies, palynofacies and depositional environment of the Upper Permian Wargal Limestone, western Salt Range, Pakistan

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Abstract

Wargal Limestone at the Zaluch Nala and Nammal Gorge sections, western Salt Range has been studied for microfacies, palynofacies and depositional paleoenvironments. The formation shows variable thickness at the Zaluch Nala (i.e. 168 m) and Nammal Gorge section (i.e. 141 m) and is divided into five lithological units. In general, the formation shows dominant limestone with intercalations of thinly laminated shale beds in almost all units studied at these sections; however at the Zaluch Nala, a sandy unit, rich in terrigenous sediments is also encountered. The limestone is nodular, thin to thick bedded, having wavy beds and chert nodules in places. Based on allochems and matrix, a total nine microfacies have been identified within the Wargal Formaton, which include; 1. Peloidal packstone, 2. Echino-packstone, 3. Mudstone, 4. Calci-mudtone, 5. Quartz rich facies, 6. Dolomitic mudstone, 7. Algal boundstone, 8. Bioclastic wackstone-packstone and 9. Bioclastic packstone-grainstone. The microfacies, and the fauna therein and palynofacies, i.e. sedimentary organic matter type (representing dominant amorphous organic matter and phytoclasts) support an intertidal to middle shelfal setting for the deposition of the Upper Permian Wargal Limestone, Salt Range, Pakistan.

The thermophysics of Hunder Glacier of Eastern Hindu Kush

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Abstract

Mountain glaciers covered with different thickness of debris have their own thermal resistance and its influence on ablation zone. The comparison of thermal resistance data at regional and global level allows estimating augmentation run-off from glaciers in relation with climate change. The thermal resistance studies show caucuses southern and northern glacier basins especially Djankuat glacier high resistance value then world. The Baltoro glacier of Karakoram Range has less thermal resistance in compression with Djankuat glacier. Therefore, an attempt has been made to evaluate thermophysics model of Hunder glacier of Eastern Hindu Kush situated in Yasin Valley of Gilgit-Baltistan. The glaciers of Eastern Hindu Kush of Yasin are less studied in relation with glaciers of Karakoram Range.

The objective of present study was to study thermal resistance of Hunder glacier of Eastern Hindu Kush gateway of westerlies and high solar radioactivity situated at higher altitude then caucuses's glacier and correlate with Djankuat and Baltoro Glacier of Karakoram Range. The mathematical modeling of vertical thermal gradient of Hunder Glacier of Eastern Hindu Kush illustrates high thermal resistance. The correlation of thermal resistance with available thermal resistance of different glaciers of Karakoram Range, Altai, and Caucuses allows suggesting Hunder glacier has high thermal resistance in the world. It is also observed that Hunder Glacier has tension flow in accumulation zone and compression flow in ablation zone. Whereas Djankuat glacier is characterize with alternation of tension and compression flows. The presence of vegetation on debris covers demonstrates stability of Hunder Glacier.

Structural evolution of South Eastern Kohat deciphered through 3D geoseismic model using move software, Shakardarra Area, KPK, Pakistan

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Abstract

Geologically Shakardarra is evolved through multiple episodes of deformation. In the current research structural evolution of south eastern Kohat is shown through 3D geoseismic model. It is prepared by integrating surface structural geological data and subsurface seismic reflection data. At surface doubly plunging anticlines and synclines are evolved on evaporites as detachment folds truncated by thrust faults along their limbs. In subsurface stratigraphic packages are marked on seismic sections based on regional stratigraphic studies and dominant reflections. The seismic data shows that thrust faults emanates from basal detachment located at sedimentary crystalline interface cutting up section to surface or lose their displacement to splay or back thrusts. At surface Shakardarra fault, Tolabangi fault, Chorlaki fault and axial trend of fold changes their strike from EW to NS which narrates that thrust and axial trend of folds are rotated along vertical axis by influence of Kalabagh strike slip fault. The current research suggests that Shakardarra is sequentially evolved in three episodes of deformation. In the first phase detachment folds developed on Eocene evaporites which are truncated by thrust faults emanating from basal detachment in second phase. In the third phase early formed folds and faults are rotated along vertical axis by the influence of Kalabagh fault.

Structural styles in Raskoh Range, Pakistan

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Abstract

A variety of structural features e.g. nappes, folding of varying wavelengths and strike slip faults showing complex structural styles exhibited in Raskoh Range, Balochistan. The nappes are present in NNW periphery of Raskoh Range and more than 10 km displacement was observed along one of the thrust sheets where Kuchakki Volcanics have been emplaced on Paleocene-Oligocene age Pishi Group. At places, obduction of ophiolites mélanges was also observed along these thrusts. Structural features particularly thrust faults take large turns and follow upto some extent the structural contours of intrusive bodies exposed in NE part of Raskoh Range. Suits of large scale folds having wavelengths in kilometers were observed in the central and western part of Raskoh Range whereas folds with relatively shorter wavelength were observed in the SE part where Eocene age Kharan Limestone occurs between Rakhshani and Nauroz formations. The fold axis has been dissected by set of NE-SW trending strike slip faults particularly southeastern part of Raskoh Range.

Field observations, structural cross-sections and kinematic analysis led to the conclusion that deformation in Raskoh area was probably started during Oligocene after the deposition of red beds of Nauroz Formation, the youngest strata present in the range. It is also concluded that Kharan Limestone acted as competent layer during folding of the entire strata and shaped wavelength of the folds according to its thickness in SE part of the Raskoh Range. Recent Nala deposits are nearly horizontal which show that there are minimum chances of Neo-tectonics. However, presence of strike slip faults those have dissected the pre-existing folds suggests possibility of recent episode deformation.

Giant Attabad landslide dammed the Hunza River, Gilgit-Baltistan, Pakistan

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Abstract

Landslides occur normally in mountainous areas in response to a wide variety of terrain conditions and triggering processes such as heavy precipitation, cloudbursts, earthquakes, floods and human activity. Continent-wise, Asia suffers the maximum damages/losses due to the landslides in general and the south Asian nations, in particular, are the worst sufferers. Further, among south Asian countries, Pakistan among the most affected countries.

In Pakistan, nearly 15 to 20 % of its territory is prone to various degrees of landslide hazard, frequently affecting the human life, livelihood, livestock, infrastructures and natural resources. Landslides are spread over the north and northwestern part of Pakistan particularly in KP and Gilgit-Baltistan (GB). The most sensitive areas are Himalaya-Karakoram-Hindu Kush Ranges.

Attabad is a remote village in Gilgit-Baltistan situated on the right bank of Hunza River at a ground distance of almost 125 km from Gilgit city. The village constitutes over 100 settlements with approximate population of 800 individuals. The 4th January, 2010, landslide at Attabad was a complex failure on a slope with known stability issues, which involved a massive movement of over 50 Mm^3 of rocks and that created a blockade on the Hunza River. Previous field work at the site, by the geologists from FOCUS Humanitarian Assistance, Pakistan, allowed evacuation of the potentially unstable area. One mudflow which travelled downstream for about 1.5 km, latter hit a small settlement close to the river at Sarat, killing 19 people. In the Hunza River, closer to the study area, two historical landslide dams have been recorded, though with limited detail. One landslide dam occurred in 1874 in Salamanabad and another was reported further upstream in between Gulmit and Shishkat in 1958. However, the field evidence for lake forming behind a landslide dam indicates a much larger feature than any event reported in historical document.

The natural damming of rivers by landslides is a significant hazard in the seismically active mountainous terrain of north and north-western part of Pakistan. There is increased awareness that river-blocking landslides have been more widespread than the documentary records suggest and that Quaternary sediments traditionally assumed to be fluvial terraces may need to be re-interpreted. The recognition of palaeo-landslides capable of creating very large lake volumes necessitates reappraisal of hazard assessment. Therefore, geological and geomorphologic methods to identify landslide hazard potential are especially important in a region experiencing rapid urban development, wide spread land use change and the construction of water and energy resource projects on major rivers. New GIS and Remote Sensing techniques based on the interpretation of aerial photographs, satellite imagery, digital elevation models and development of spatial database and landslide modeling are enabling more detail about past and present landslide distributions to be generated. The need for vigilance in assessing seismically slope in stability hazards is apparent.

Remote sensing based seismic site characterization

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Abstract

Earthquakes with their unpredictability and most devastating nature is become a challenge for scientists and organizations around the world. To mitigate the devastating impacts of earthquake, seismic microzonation is frequently used to demarcate locations that are prone to amplified seismic response. The shear wave velocity of top 30m surface (Vs^{30}) is frequently and effectively used as an indicator of seismic microzonation. Remote sensing derived terrain slope is used as proxy for terrain slope (Wald and Allen 2007). The remote sensing derived geomorphic units are used as a proxy to estimate Vs^{30} (Yong et al. 2008; Shafique et al. 2012). However, these studies are lacking the field measured Vs^{30} data and hence the estimated Vs^{30} might be unreliable. The aim of this study is to measure the Vs^{30} in the field and correlate it with remote sensing derived terrain slope and geology to develop a more realistic seismic microzonation map for the study area of Balakot in northern Pakistan. We have collected 145 field measurements for Vs^{30} using geophysical instrument (Micromed Tromino Engy) on the selected geological units and classified slopes in the Balakot valley. The collected Vs^{30} measurements are subsequently correlated with the remote sensing derived terrain slope and geological formations. The final output this study is the Vs^{30} based seismic microzonation map for the Balakot valley. The map can be used by the relevant organizations and agencies to formulate strategies for earthquake management.

Overview of the petrologic evolution of the mafic-ultramafic Jijal Complex in the Kohistan Himalaya of Pakistan

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Abstract

Jijal complex represents the magmatic roots of the Cretaceous Kohistan Island arc. It covers about150 km^2 in the hanging wall of the Indus Suture. The southern part of the complex compises a >10 x 4 km slab of UMR: pyroxenites (diopsidite > websterite), dunite, wehrlite), subordinate harzburgite, and minor chromitite. The peridotites contain Cr-spinel, but are devoid of garnet and plagioclase. These rocks are locally well-layered, variably serpentinized, show plastic and brittle deformation, and are cataclacized near the suture. Petroogical and geochemical studies suggest that UMR were derived from a subduction-related high-Mg basalt or boninitic magama.

Overlying the ultramafic rocks is a 7 km wide belt of garnet granulites, represented mostly by the assemblage Grt + Cpx + Pl + Qtz + Rt ± Hbl. The granulites are locally well-layered and some of the layers comprise garnet pyroxenites, garnetites, and anorthosite. More significant are pods and elongated bodies of garnetites and hornblendites. The granulites display a range of prograde and retrograde assemblages:

1) Pyroxene granulite facies relectual enclaves in garnet granulites:
   Pl + Opx + Cpx ± Hbl (meta-norite) Cpx ± Opx + Spl (meta-pyroxenite)
2) Garnet granulite facies assemblages:

Common Granulite	*Garnetite*
Pl + Grt + Cpx + Qtz + Rt ± Hbl	Grt + Cpx + Qtz + Ep ± Hbl
Pl + Grt + Qtz + Rt ± Hbl	Grt + Cpx + Hbl + Rt ± Qtz
Pl + Qtz + Grt + Ep ± Rt	Grt + Cpx + Rt
Pl + Grt + Cpx + Scp	Grt + Hbl + Ep + Rt
	Grt + Hbl
Pyroxenites	*Hornblendites*
Cpx + Grt ± Spl	Hbl + Grt + Rt
Cpx + Opx + Grt ± Hbl	Hbl + Grt + Cpx ± Rt
Cpx + Opx + Grt ± Spl	Hbl + Grt + Pl
	Hbl + Grt + Ep + Qtz + Rt
Meta-Anorthosite	*Vein in garnet Hornblendite*
Zo + Grt ± Cpx ± Hbl ± Qtz	Cpx+Grt+Hbl

3) Retrograde assemblages:

Amphibolite Facies	*Greenschist Facies*
Grt + Hbl + Pl + Ep + Rt ± Scp	Am + Ep + Qtz + Phen + Crn + Rt
Zo + Ky + Pg ± Crn	Pl + Qtz + Chl + Ep
Zo + Qtz + Grt + Hbl + Ky + Pg	Ep + Phen + Chl + Am
Hbl + Ep + Grt + Qtz + Pl + Pg + Rt	Ep + Chl + Am + Sph + Ab
Hbl + Ep + Scp	Ep + Ab + Pg ± Act
Hbl + Ep + Qtz	Act + Chl + Ep ± Ab

The origin of garnet and, hence, the nature of the protolith of the granulites and garnetites are controversial. However, these rocks also seem to be derived from subduction-related magma(s) and, like the UMR, underwent medium-P granulite facies metamorphism during the Early Cretaceous (118 Ma). This was followed (96-90 Ma), by high-P granulite facies metamorphism (800-1000^o C, 12-17 kbar) when the arc was possibly thickened to more than 40 km. In the waning stages of this metamorphism (~ 83 MA), hornblendite bodies were emplaced. During uplift, a range of hydrous assemblages were locally overprinted on the granulite assemblages. The presence of Jijal-type garnet in the foreland (Siwalik) molasse suggests that the complex was exposed to erosion 15 Ma ago.

Calculating and integrating the extent of pollution loads for toxic and major elements in the soil of Gadoon Amazai, Pakistan

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Abstract

The current study was carried out in Gadoon and surrounding areas in order to investigate and calculate the pollution load released by industrial state. A total of forty five samples were collected with twenty five soil samples from focus area and twenty samples from the background area. All these soil samples were analyzed for thirteen major and toxic metals using Perkin Elmer Atomic Absorption Spectrophotometer (AAS-700) equipped with Graphite Furnace (GF).

The results show that the mean concentrations of toxic metals (mg/kg) in the target area are 301.6, 8.8, 152.3, 58.8, 144.7, 359.4 and 32.5 for Cr, Cd, Pb, Ni, Cu, Zn and Co respectively, While the mean concentration of major elements (mg/kg) are 1097, 2508, 786.5, 2572, 4088.9 and 689.8 for Fe, Mn, Mg, Na, Ca and K respectively. Mean concentration for major and toxic metals (mg/kg) for background area are 93.6, 6.1, 35.5, 55.9, 59.1, 116.4,24.1, 644.3, 1112.3, 549.4, 1275.1, 2364.4 and 995.2 for Cr, Cd, Pb, Ni, Cu, Zn, Co, Fe, Mn, Mg, Na, Ca and K respectively. Several approaches such as pollution load index, risk index, contamination degree, new pollution index etc. were applied in order to infer anthropogenic contribution. The majority of the toxic and major elements are contributed to soil pollution, but the toxic metals have high influence on the environment as compare to major elements. Therefore, industrial and commercial areas are prone to higher potential ecological risk when compared with background area. There is strong need for remediation and mitigation activity in the study area which could help to minimize the pollution loads produced by the Gadoon Amazai Industrial state.

Flood monitoring and early warning system for Pakistan

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Abstract

Pakistan has been a flood disaster hit state from decades with 20 major floods reported from 1950 till 2012. These floods affected an approximate area of 0.6 million square kilometers and killing about 11 thousand people with Rs 0.39 billion damage to the economy (federal flood commission). It is being observed that the floods are more damaging in the last decade and this damage is increasing with time, affecting all areas from housing, health, education, communication to agriculture and industrial sector. This increase in damage is mainly due to the absence of a disaster management system. In view of this, we have established an open source technology based system for monitoring the river water level along with an early warning system in case of any flood. The system has a level measuring electronic system on each of the gauging point. The real time monitoring is coordinated to the base station through GSM module. There is an automated application monitors the readings and in case of a flood generates an alarm. The alarm triggers the early warning system, sending short messages through GSM SMS service to the residents of the areas in imminent danger of flood. The system incorporates mobile numbers database from the local telecommunication companies to identify the residents that might be warned of the approaching flood. Additionally for research and pattern analysis study, the data is also stored in the database with the acquisition time stamp. This data has also been published on the internet for public knowledge and use.

Kulli Koh iron ore deposits, district Dalbandin, Chagai, Balochistan, Pakistan: A case study

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Abstract

The Kulli Koh area falls in the eastern part of Northern Chagai Arc, within the eruptive zone of the Balochistan Geosyncline. The Northern Chagai area was probably initiated as an Island Arc during Early Mesozoic bordered on the south by a deep Geosyncline i.e the Dalbandin Trough. The different phases of volcanism during late Cretaceous to Pleistocene have been noticed in the area.

The oldest rock unit exposed is the Sinjrani Volcanic Group of Late Cretaceous Age. During this period, volcanism has been the most extensive and widespread and resulted in deposition of 1000 to 1200 meter thick assemblage of volcanic rocks including agglomerate, tuff and lava. In the western part of the Chagai Arc, these volcanics are intermixed with shale, sandstone and limestone. Overlying Sinjrani Volcanics is the Humai Formation of Late Cretaceous age.

The Great Chapper Fault passes at 1.5 to 2 Km south of the mineralized area trending almost in East-West direction. This great fault, in general, divides the Sinjrani Volcanics from the sedimentary rock units i.e., Humai and Rakhshani Formations, in the adjoining region. The fault has given rise to a number of off-shoot faults in the area. Mostly mineralization has been noticed along or in close proximities of the fault planes identified in the area.

The iron ore deposits in the Chagai District are mostly volcanogenic and are in the form of vein filling or semilunar, wedge shaped tapering bodies of variable thickness. These deposits have a good potential as many hidden fumerolic centers might be present around the two main strato – volcanoes and other large number of volcanic centers in the region. The Kulli Koh area is fairly rich in iron ore (Magnetite, Hematite and Micaceous Hematite). Iron ore is mostly found, in two kinds of environment; these are either in form of veins of varying exposed dimensions, associated with, diorites representing Chagai intrusions or volcanogenic rocks mostly andesite, representing the Sinjrani Volcanics.

Mostly, the magnetite or hematite found in veins of mostly irregular nature but at some places, the ore body parallels the enclosing diorites. At some places, the ore bodies cut and intrude into the enclosing host rocks. The iron ore deposits associated with volcanic rocks sometimes become large, especially where the bodies are found within or close to the felsite bodies. On the basis of clustering of outcrops of iron ore and its potential, eight blocks have been identified in the Kulli Koh area. The grade of the iron ores found in the area range from medium to high grade. Sulphur, copper, quartz, calcite and phosphorous are within the permissible limits for metallurgical purposes.

A large number of private / local contractors have been engaged in mining and producing iron ore at an average of 24,000 tonnes per annum. Very safe assessment made during present investigation indicates that this production can at least be doubled by taking various necessary steps.

Geological mapping as a technique to establish the stratigraphy and structural framework of a part of Hazara Kashmir Syntaxis, Kotli district, Azad Kashmir, Pakistan

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Abstract
The molasses sequence is highly deformed into folds and faults. The main folds in the area are the Gulpur Syncline, Nar Anticline, chomeri Syncline, Brotian Anticline and Rajdhani Syncline.

The folds are open and southwest or northeast vergent. The Nar Anticline and Barotian Anticline form the structural traps for oil and gas exploration in the area.

The faults present in the area are the Changpur Normal Fault, Bajwal Reverse Fault and Chillayar Normal Fault.

The Gulpur Syncline and Fagosh Anticline are developed as hanging wall syncline and foot wall anticline along the Changpur Fault, respectively. The Bajwal Fault is northwest-southeast trending and northeast dipping reverse fault. The Chillayar Fault is a normal fault. It is normal on the surface and reverse in the subsurface.

Triassic-Jurassic boundary: Evidences from the Tethyan Salt Range, Pakistan and correlation with Europe

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Abstract

The Early Jurassic Datta Formation, Salt Range, Pakistan, represents dominantly siliciclastics with some carbonate accumulations. The lower contact of the formation is disconformable throughout its extent, with various older rocks (Precambrian to Triassic in age) and in the Salt and Trans Indus ranges, it disconformably overlies the Triassic Kingriali Formation. The geological evidences from western Salt Range display abrupt emergence and associated facies dislocation, along a type 1 sequence boundary, from dominantly marine succession of the Kingriali Formation (dolomite) to pure fluvial/continental succession of the lower part of the Datta Formation. The basal part of the formation contains conglomerates and pebbly sandstones with channel fill features and erosive bases and contains angular, poorly sorted clasts of dolomites derived from the underlying Kingriali Formation. The presence of a thick laterite bed, having bohemite, kaolinite and similar minerals further indicates weathering under continental and tropical conditions (i.e. emergence). This interface represents the Triassic-Jurassic boundary, an event of global significance and well-established in Europe, represented by erosion, karstification, channels with erosive bases and reworked clasts of the underlying Triassic sediments. In England, the marine Hettangian Blue Lias Formation rests on an eroded top of the Rhaetian Penarth Group, with the upper Lilstock Formation being partly or wholly missing and reworked limestone clasts at the base of the Blue Lias have been discovered. In northern Frankonia (Bavaria) of Germany, fluviatile Hettangian occurs in marine channels cut into Rhaetian sandstones and clays and is overlain by marine Hettangian of the planorbis Zone. An end-Triassic regressive pulse is recognised in the Danish Basin; in southern Sweden and north-west Poland, the Upper Rhaetian is missing and an unconformity exists at the base of the Jurassic. In the Northern Calcareous Alps of Austria, widespread emergence at the end of the Triassic is also recognised with the creation of karst surfaces on emergent reef complexes and erosion and channeling is present. The Triassic-Jurassic boundary (Hettangian) GSSP in Austria includes a regressive marine red shale interval on top of the Rhaetian (Schattwald Formation) terminating in a sea-level lowstand, followed by transgressive Hettangian strata. This stratigraphically significant sea-level event coincides closely with one of the five biggest mass extinction events in the Phanerozoic. However, the event has been overlooked by Haq et al. (1987), who recorded no significant sea-level change across the system boundary. The presence of sedimentological evidences for the globally present Jurassic-Triassic boundary, invites a robust biostratigraphic (i.e. palynostratigraphic) study of the Datta Formation to establish the chronostatigraphic order of the unit with respect to the European time-equivalent successions.

Petrology and geochemistry of the dykes from the Muslim Bagh Ophiolite Balochistan, Pakistan

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Abstract

Two different categories of dykes are found in Muslim Bagh Ophiolite; sheeted dyke complex; and the mafic dyke swarm. The sheeted dyke complex comprises of metadolerites, plagiogranites and diorites and has a poorly-developed nature with a comparatively well-developed plutonic section underneath. This configuration of the Muslim Bagh crustal rocks implies that the sheeted dykes have formed in a oceanic setting with the low magma supply in pulses and in different times, that fractionated; possibly, a thick accumulation of cumulate rocks in the magma chamber, and resulted in a less well-developed sheeted dyke complex. Both the sheeted dykes and dyke swarms are hydrothermally metamorphosed to greenschist and amphibolite schist rocks. Except the upper level gabbros, the dyke swarms almost crosscut the whole ophiolite sequence including the metamorphic sole rocks but are truncated structurally at the contact with the underlying mélange and sediments. The relationship between the dykes and ophiolitic rocks indicate that dyke swarms' emplacement postdated formation of the Muslim Bagh Ophiolite and the formation of metamorphic sole rocks. However, the dyke's intrusion predates the accretion of mélange the final emplacement of ophiolite onto the Indian continent margin. Both the sheeted dykes and dyke swarms show geochemical composition of being tholeiitic in nature, and have the geochemical characteristics between the Mid-oceanic ridge basalt (MORB) and Island arc tholeiite (IAT). These geochemical characteristics are evidenced by the higher contents of large ion lithophile elements (LILEs) and flat pattern of the high field strength elements (HFSEs) and with no depletion in the light rare earth elements (LREEs) and almost straight pattern of heavy rare earth elements (HREEs). Generally oceanic rocks exhibiting such characteristics are thought to have involvement of subduction component in the source region by fluids along the subduction zone and are formed in a supra-subduction zone tectonic setting. The Muslim Bagh Ophiolite sheeted dykes originated in the late Cretaceous, in a supra-subduction zone tectonic setting related to the west or northwest dipping subduction of a narrow branch of Neo-Tethyan Ocean, followed by subduction rollback due to splitting of the nascent arc in the Neo-Tethyan Ocean. This intra-oceanic subduction led to the formation of a metamorphic sole, followed by the intrusion of mafic dykes into the ophiolite, off-axis, through a slab window. The Muslim Bagh Ophiolite accretes the Bagh Complex and finally obducted over the Indian Platform.

Structures and tectonics of the western margin of the Indian Plate

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Abstract

Ongoing collision of the Indian and Eurasian plates since about 55 Ma has led to the development of the spectacular Himalayan mountain system. Western margin of this system is characterized with a zone of transpression marked by the Chaman fault system and the development of an arcuate and broad ((~500 km) Sulaiman fold belt. This area is recognized with huge petroleum reserves. Therefore, better understanding of geological structures is considered as a key to successful exploration. In this article, combined surface geology (field geology and Landsat image interpretation) and subsurface geophysical (seismic reflection, gravity, and seismicity) data is used to depict, analyse, and interpret the deformation and the evolution of the active western margin of the Indian plate (Jadoon et al. 1992, 1994; Jadoon and Khurshid 1996).

A regional 800 km long, NNW-SSE crustal-section, shows tectonic units across the margin (N to S) as the Afghan block, the left-lateral strike-slip Chaman fault (since the early Tertiary), the Khojak flysch basin (Eocene-Miocene), the Muslimbagh ophiolites (late Paleocene-early Eocene), and the Sulaiman fold belt (Triassic-Eocene platform and Neogene molasses sedimentation). The broad (>300 km) and gentle (<1°) Sulaiman fold belt is characterized with the presence of about 10 km strata of stratigraphic thickness, without any thrust fault, at the deformation front. Absence of a thrust at the mountain front is interpreted with, thin-skinned, duplex-style of deformation over a weak detachment. The detachment is interpreted with a depth of about 10 km at the mountain front as Paleozoic to Recent stratigraphic section is buckled as folds (Sui and Loti) over the basement. The duplex structures are interpreted starting from the Pirkoh northwards. The duplex sequence, is comprised of Paleozoic to Jurassic strata, which is topped by a hinterland vergent roof-sequence, of Cretaceous and younger strata. The roof sequence extends over a considerably long distance (~149 km) emerging in the Loralia valley. Along its length, it is breached by a set of exposed thrust faults, of limited displacement, both with foreland and hinterland vergence in the internal part of the system, unlike nappe structures (Bannert). Thus, it is interpreted to deform with active out-of-sequence deformation evidenced with very high degree of seismic activity in the central Sulaiman fold belt. Critical review of this deformation with the Landsat data shows the presence of right-lateral strike-slip faults of EW orientation, obliterating former fold-and-thrust structures. These strike-slip faults are interpreted to represent the youngest Quaternary deformation with anticlockwise block-rotation in the system, possibly due to transpression. We have calculated shortening of about 349 km with convergence rates of about 18mm/yr, since about 20 Ma across the Sulaiman fold belt, south of the Muslimbagh ophiolites and the Khojak flysch basin along the margin.

With gravity data, the curst is modeled as thinner (15-27 km thick) along the Sulaiman fold belt and thicker (~57 km) along the Afghan block across the Chaman fault. This implies presence of a preserved passive margin along the western terminus of the Indian plate. The modeling suggests the Chaman fault to be generally vertical, with juxt-opposition of basement (Afghan Block) towards north and flysch Khojak) towards south. It is interpreted to be restricted at depth to about 15 km with mergence in the decollement over the subducting passive margin of the Indian plate. Thus, the Afghan block is interpreted as an oblique indenter with dominant left-lateral strike-slip along the Chaman fault and thrusting in the Sulaiman fold belt. Deformation partitioning, with transpression in the sedimentary wedge above a decollement and pure translation of the lithosphere with indentation of the Afghan block is considered in our model.

Attabad landslide risk management

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Abstract

Landslides are among the most destructive natural disasters in the Himalayan Karakorum Hindu-Kush mountain ranges which possess some of the largest glaciers in the world. The northern part of Pakistan, Gilgit-Baltistan, falling in this region is no exception to that. Attabad is a remote village in Gilgit Baltistan situated on the right bank of Hunza River at a ground distance of almost 125 km from Gilgit city. The village constitutes over 100 settlements with approximate population of 800 individuals. The upper part of the village was settled on slope profile, a landslide prone area, which was activated several times in past and the locals were evacuated from the area prior to the disaster event.

The devastating landslide incident occurred in Attabad near Hunza on the 4th of January, 2010 at 12:10 pm. The rock fall events started 2 days before the disaster event on the eastern end of the unstable slope. The people were already evacuated from Attabad (Bala) due to the movement of the landslide. The whole slope mass including hard rock and unconsolidated material detached suddenly from the slope. The debris material hit the opposite side rock ridge and landslide mass diverted with air pressure due to narrow gorge towards upstream and downstream direction. As a result of debris surges downstream 8 houses in lower Attabad came under the rubble in which 19 people were killed and several inured.

FOCUS Pakistan undertook a study where the occurrence and impact of the seismic events and anthropogenic activities in the activation of the landslide were analyzed. The study also highlighted the lake monitoring data (lake level, seepage and flow data before overtopping and after overtopping) and the installation of an Early Warning System. The lake is still present in the valley. Through the timely risk anticipation the precious lives in Attabad were saved and almost 25 houses at high risk were evacuated and saved.

Monitoring of the Attabad Lake provided an updated data on the increasing level of the lake, inflow at the upstream and seepage at the toe of the dam which enabled the local government, NGOs other stakeholders to take timely decision to reduce the risk of any outburst flood.

Lithofacies associations and depositional environments of the neogene molasse succession, Pishin Belt, Northwestern Pakistan

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Abstract

The Pishin Belt is NE-SW trending flysch and molasses basin, in northwestern part of Pakistan, bordered by Eurasian Plate (Afghan Block) in the west and Indian Plate in the east. Western boundary of the belt is marked by well-known Chaman Transform Fault, whereas the Zhob Valley Thrust and Muslim Bagh-Zhob Ophiolite mark the eastern boundary. The Neogene molasse succession of the Pishin Belt comprises the newly identified Middle Miocene Dasht Murgha group, Late Miocene-Pliocene Malthanai formation and Pleistocene Bostan Formation. In the Neogene succession twelve distinct lithofacies have been recognised and grouped into four types of facies associations. Lithofacies include clast-supported massive gravel (Gcm), clast-supported crudely bedded gravel (Gh), cross-stratified conglomerate (Gt and Gp), trough cross-stratified sandstone (St) planar cross-stratified sandstone (Sp), ripple cross-laminated sandstone (Sr), horizontally stratified sandstone (Sh), low-angle cross-stratified sandstone (Sl), massive sandstones (Sm), massive mudstone and siltstone (Fm) and paleosol carbonate (P). The lithofacies associations include channel facies association (CHA), crevasse-splay facies association (CSA), natural-levee facies association (LVA) and floodplain facies association (FPA). The lithofacies associations suggest that the Dasht Murgha group was deposited by a sandy braided to mixed-load high-sinuosity fluvial system. The Malthanai formation was deposited by a mixed-load high-sinuosity fluvial system and Bostan Formation was deposited by gravelly braided channels of a coalescing alluvial fan system.

We postulate that prolonged and continued collision of western margin of the Indian Plate with Afghan Block resulted in closure of the Katawaz Remnant Ocean (southwestern extension of Neo-Tethys) in Early Miocene. Uplifted orogens of the Eocene to Oligocene marine succession of the Nisai and Khojak formations served as a source terrain for the deposition of Miocene through Holocene continental molasse succession in the south and southeast verging successive thrust-bound foreland basins at the outer most extremity of the Pishin Belt.

Focal mechanisms computation and seismicity distribution of major earthquakes in lesser and Central Himalaya

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Abstract

Pakistan is a country with moderate to high seismicity, as it is situated at the junction of the world's three great mountain ranges: The Himalaya, The Hindu Kush and the Karakoram. The severity of seismic hazards of major seismic events is not ignorable. The focal mechanism solution and spatial distributions of major earthquakes of local magnitude > 4.5, occurred in lesser and central Himalaya, mostly in the northern and central parts of Pakistan in the last fifty years, are examined and discussed. The earthquake data of three international catalogues is used along with computer based algorithms. The spatial distribution of their epicenters as a function of depth shows that most of the earthquakes are shallow to intermediate depths. The relationship between major faults and their source mechanism is also investigated. The majority of the focal plane solutions in the study area show strike-slip faulting with a left-lateral sense of motion, followed by thrust faulting along with some normal faulting. The subduction of the Indian plate under the Eurosian Plate is a source of some of the major events with thrusting and reverse faulting. These low-to-intermediate angle thrust faulting is dominant to a depth 40 – 70 km. This suggests that the Indian plate is moving with respect to the Eurasian plate along the Chaman fault, Quetta Transverse Zone, the Suleiman Ranges and the Hazara thrusts region joining the Hazara/Kashmir syntaxis. It is seen that in a large number of events the compressive stress is acting nearly in NNW-SSE to N-S directions. For deeper events, focal mechanism solutions are mostly characterized by down-dip compression in both lesser and upper Himalaya.

Post-earthquake environmental hazards in Balakot, Khyber Pakhtunkhwa, Pakistan

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Abstract

In this study soil radon concentration measurement were carried out near the Balakot Bagh Fault line (B-B) and in the surrounding areas of 2005 earthquake Hazara KPK- Pakistan using an active technique of RAD-7 for alpha spectroscopy. The aim of the study was to assist the post earthquake environmental hazards to the people of the area. The measurements were taken in the summer season (16 May to 15 August) 2013. Soil gas radon concentrations were found higher near the B-B fault line with an average value of 11.9$kBqm^{-3}$as compared to other sites of the study area which average value was around 4$kBqm^{-3}$. The mean value of soil gas radon concentrations in the whole study area was found as 7.6 $kBqm^{-3}$.

Precious metals and heavy minerals studies in the stream-sediment and pan-concentrate samples from Bannu Basin, Khyber Pakhtunkhwa, Pakistan

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Abstract

Stream, pan-concentrate and Quaternary sediment samples from the Kurram River, and its tributaries (Tochi, Gambila, Kashu etc.) in Bannu Basin were studied in the perspective of gold, silver, base and other precious metals and heavy minerals. A total of 292 samples including 185 of stream sediment, 46 of pan-concentrate and 61 of Quaternary sediment samples were collected from outlet points of watersheds representing at least more than 15 km^2 drainage basin generated through GIS 10.1 software from DEM data. The gold grains encountered in the pan-concentrate samples were studied for knowing its morphological characteristics under stereo-microscope. The stream sediments, pan-concentrate and Quaternary sediment samples were treated in the geochemistry lab for analysis through atomic absorption to determine concentration of gold, silver and base metals. The pan- concentrate samples were studied for heavy minerals content under stereomicroscope.

Stereo-microscope was used to describe morphological features and parameters of gold grains were noted both qualitatively and quantitatively. Gold grains from all the samples ranged in size from 70 μm - 10 μm along their longer dimension. Gold grains display abundant abrational features such as pitting, etching, grooves and cavities, folding, with primary features only rarely preserved. Morphological parameters like flatness ratios (ratio of length and breadth to thickness), roundness, degree of bending, shapes on preffered lying sides and surface textures etc. indicate that the grains have undergone appreciable transport (hundreds of kilometers) from the source region.

Geochemical concentrations of 10 precious and base elements were determined by standard atomic absorption techniques in all the 292 samples. In stream sediments the concentration ranges in ppm were: Au (0.01-1.91), Cu (0.002-1.13), Zn (0.001-1.75), Cr (0.001-3.38), Ag (0.0015-0.319), Co (0.003-0.95), Ni (0.002-9.11), Pb (0.001-1.71), Cd (0.001-0.44) and Mn (0.483-17.99). The ranges of elemental concentration in the pan-concentrate samples in ppm were: Au (0.009-5.14), Cu (0.003-2.46), Zn (0.14-1.1), Cr (0.28-3.78), Ag (0.03-2.7), Co (0.02-0.63), Ni (0.01-2.324), Pb (0.004-0.65), Cd (0.001-0.11) and Mn (1.37-21.45). The ranges of elemental concentration in the Quaternary sediment samples in ppm were: Au (0.002-0.5), Cu (0.007-0.98), Zn (0.02-2.02), Cr (0.02-1.93), Ag (0.001-0.43), Co (0.004-0.513), Ni (0.006-2.78), Pb (0.002-0.77), Cd (0.003-0.19) and Mn (1.63-18.98).

The heavy mineral suite in the pan-concentrate samples from the study area, as determined with the visual inspection and stereo-microscopy, includes magnetite, garnet, zircon, epidote, amphibole, tourmaline, apatite and monazite, in decreasing order of abundance, along with minor amounts of gold, rutile, illmenite, spinel, olivine, pyroxene and chromite.

Geochemical exploration for Au, Ag and base metals in Kohat Plateau, Pakistan

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Abstract

Stream sediments geochemistry is extensively used in mineral exploration in any part of the world. Reconnaissance studies have been carried out in order to delineate geochemical anomalies in Kohat plateau. Majority of the streams in the study area receive sediments from Siwalik rocks deposited by paleo-Indus River, Hill Ranges (Paleocene to Cretaceous rocks) and also from Quaternary deposits in the study area. The geochemical survey involve collection of stream sediments (-80 mesh), heavy mineral concentrates (HMC) and samples of Quaternary deposits from various catchment basins at a sampling density of more than 10 square kilometers.

All the samples were analyzed for Au, Ag, Cu, Zn, Cr, Pb, Ni, Co, Cd and Mn using atomic absorption spectrometer (Perkin Elmer 700).

The results for various elements were processed by combination of geostatistical and GIS analysis to display broad-scale regional distribution of the elements on the basis of single elements consideration and to delineate anomalous areas of most interest for further follow-up. A combination of univariate, bivariate and multivariate statistical analysis indicate that Au in the study area is poorly associated with Ag, Cu, Zn, Cr, Pb, Ni, Co, Cd and Mn indicating the lack of source in the study area. Among all the elements Au was found to have significant concentration. High Au concentration (2-13.5 ppm) in the study area has been noticed in HMC as compared to the stream sediments (0.3- 1 ppm). This high concentration of gold is indicative of existence of potential placer gold deposits in the Kohat plateau. Detailed geochemical exploration program in this regard is in progress to understand the provenance and economic potential of gold in the region.

Economic evaluation and provenance of placer gold from district Charsadda and Nowshera, Pakistan

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Abstract

Charsadda and Nowshera districts are located N-W and S-E in Peshawar basin and comprises River Kabul, Swat, Naguman and seasonal tributaries. Regional geochemical survey was carried out to assess the economic potential of stream sediments and pan concentrates. All the stream having catchment area up to 25 km were marked for samples collection. A total of 51 pan concentrate (HMC) and 124 stream sediment (SS) samples were collected from the study area. Both HMC samples and SS samples were analyzed for Au, Ag, Cu, Pb, Zn, Ni, Cr, Cd and Co using Atomic Absorption Spectrometer (AAS). Morphological features of separated gold grains (more than twenty four colors and four specks) were studied using Scanning Electron Microscope (SEM) and stereomicroscope.

Result of pan concentrates for Au Ag, Cu, Pb, Zn, Ni, Cr, Co and Cd have maximum values (in ppm) of 45, 20, 130, 203, 55, 699, 541, 36 and 6 respectively. In tributaries, maximum values for Au are 25 ppm, 6 ppm, and 4 ppm collected from Girgichi Khwar, Kheyali river and Kaga khwar in Charsadda District, while in Nowshera maximum values are 45.456 ppm, 18.065 ppm, 5.5 and 3.025 ppm from Attock Old Bridge Khwar, Shnay Wannay Khwar, Kemy khwar and Saparey Khwar respectively. Mean concentration of Au in pan concentrate samples are 3.86 ppm. Morphological features such as roundness, flatness, folding, refolding, pits and grooves of gold grains (colors, specks) have been observed using SEM images and Stereoscope Images. Majority of the gold grains are sub-rounded to well rounded, outline and shape of majority of gold grain is simple, majority of grain are flat have pits and grooves on surface showing flaky and porous appearance. These kind of morphologies are indicative of high degree of transport distance. The heavy minerals from the study area include fluorite, apatite, garnet, zircon, tourmaline, amphibole, rutile, monazite, topaz, pyroxene, magnetite, tremolite, epidote, hematite, Ilmenite and rock fragments in both the districts of study area.

From economic point of view the anomalous concentrations of Au is present in Girgichi Khwar, Kheyali river and Kaga khwar of district Charsadda and Attock Old Bridge Khwar, Shnay Wannay Khwar, Pittao Khwar, Kemy khwar and Saparey Khwar of Nowshera District. The morphology of gold grains and the presence of heavy minerals (of igneous and metamorphic origin), it can be concluded that these minerals are derived from distal sources.

Unique approaches, tools and lessons learnt in development of coal bed methane

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Abstract

The fraction of gas production from coal seams is growing steadily particularly in USA, Canada and Australia. Coal fields have several traits in common which comprise extremely low permeability and they are both the source as well as the reservoir from which hydrocarbons are produced. In hydrocarbon exploration terminology they are categorized as "Unconventional Resources". Very low permeability offered by coal compels to develop special techniques to recover the CBM; the methane gas present in coal seams as adsorbed or free gas. These techniques include horizontal drilling, drilling multilateral wells and multistage fracturing to recover the maximum possible of the methane gas. On-site coal seam-specific drilling methods were decreasing the capital cost of drilling a CBM well in last decade.

Pakistan has large coal reserves. CBM can be produced from operational mines, abandoned coal mines, and from unmined coals using surface boreholes. It is fast becoming an important energy source mainly because of the declining conventional gas resources. Methane gas in coal seams is present in two ways; free gas present in pore space and associated gas adsorbed on the coal surface. Pore gas has smaller fraction and reservoir pressure deplete rapidly, so, even after the multilaterals and horizontal wells followed by multistage fracturing have less recovery. From 1990's and onward, nitrogen gas was introduced as a recovery optimizing tool through adsorbed gas recovery. Nitrogen has certain drawbacks. It is difficult to obtain pipeline quality gas after nitrogen gets mixed with methane resulting in increased operating costs. In this paper, carbon dioxide flooding is discussed as a tool to recover least contaminated gas in a cost effective manner. It has certain benefits over other methods including environmental friendliness in the form of "Carbon Credits". This paper addresses the quality of coal to be a best candidate as CBM reservoir, different methods used for recovery and their comparison, at the end; carbon dioxide flooding and its advantages over the other methods are discussed. This paper will focus on how developed countries are maximizing their CBM production what lessons can we learn from them to partake in the energy crunch of Pakistan.

Facies and diagenetic analysis of Pab Sandstone in Rakhi Nala Section, Eastern Sulaiman Fold and Thrust Belt: implication for provenance and hydrocarbon reservoir characterization

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Abstract

A 551 meter thick section of Upper Cretaceous (Maastrichtian) Pab Sandstone has been measured and logged in the Rakhi Nala Section of the Eastern Sulaiman Fold and Thrust Belt. The succession is mainly composed of thin-thick bedded, fine-coarse grained sandstone with subordinate mudstone and occasional marl. The whole succession was deposited in the western passive margin of the Indian Plate. Eight facies have been identified in the Pab Sandstone which are grouped together in three facies associations which includes inner shelf or pro-delta, delta-front, and delta-plane facies associations. The deposition of these facies took place on flood dominated siliciclastic deltaic platform having low gradient. This Upper Cretaceous succession represents the regressive phase of deposition as indicated by several thickening upward cycles, increase in grain size and increase in bed thickness. The framework composition and petrographic classification suggest that the Pab Sandstone is sub-mature to mature, quartz arenite, sub-arkosic, and sub-lithic arenite with few sub-ordinate wackes. The physiography and tectonic setting along with NW paleocurrent direction suggests Indian Craton as the source area for the studied sandstone. The studied sandstone shows complex and intense phases of burial diagenesis. Different clay minerals observed by SEM and XRD analysis are the result of alteration of unstable framework grains and volcanic lithics. Both physical and chemical compaction, authigenic mineralization and cementation, and late stage dissolution of cement/matrix are commonly observed. Authigenic cements which include calcite, silicious cement in the form of quartz overgrowths, ferroan dolomite, iron oxide and clays are commonly observed. The primary porosity of these sandstones is almost completely destroyed by compaction and authigenic mineralization. However, dissolution of feldspar, unstable lithics and pre-exisiting cement/matrix has enhanced the secondary porosity. The petrographic studies and plug porosity/permeability results of outcrop sandstone samples suggest that thick, laterally continuous, vertically stacked sandstone sequences of delta-front lobes of the Pab Sandstone have good reservoir potential. The texturally mature sandstone of the delta-front lobes also shows good effective porosity values in subsurface as interpreted from wireline logs and thus is an excellent reservoir.

Health risks associated with heavy metals in the drinking water of Swat, Northern Pakistan

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Abstract

The concentrations of heavy metals such as cadmium (Cd), chromium (Cr), copper (Cu), manganese (Mn), nickel (Ni), lead (Pb) and zinc (Zn) were investigated in drinking water sources (surface and groundwater) collected from Swat valley, Khyber Pakhtunkhwa, Pakistan. The potential health risk of heavy metals to the local population and their possible source apportionment were also studied. Heavy metal concentrations were analysed by using atomic absorption spectrometer and compared with permissible limits set by Pakistan Environmental Protection Agency (Pak-EPA) and World Health Organization (WHO). The concentrations of Cd, Cr, Ni and Pb were higher than their respective permissible limits, while Cu, Mn and Zn concentrations were observed within their respective limits set by Pak-EPA and WHO. Health risk indicators such as chronic daily intake (CDI) and health risk index (HRI) were calculated for adults and children separately. CDIs and HRIs of heavy metals were found in the order of Cr > Mn > Ni > Zn > Cd > Cu > Pb and Cd > Ni > Mn > Cr > Cu > Pb > Zn, respectively. HRIs of selected heavy metals in the drinking water were less than 1, indicating no health risk to the local people. Multivariate and univariate statistical analyses showed that geologic and anthropogenic activities were the possible sources of water contamination with heavy metals in the study area.

Lithofacies and petrographic analyses of Laki Formation: implications for petroleum potential resorvoir

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Abstract

The present study is intended to describe lithofacies and petrographic studies of the Laki Formation and its implications for petroleum potential reservoir. The Laki Formation is mainly developed in the southern part of the Kirthar Province and in the vicinity of the Marri-Bugti hills in the Sulaiman Province. Its type locality is Mari Nai (Lat. 26˚06'N: Long. 67˚51'E), southwest of Bara Nai, of the northern Laki Range. In Sui, it has been encountered in different wells and attains the thickness of 468 m. However, study area of Laki Formation comprises eastern part of the Surjan Anticline, 5 km northeast of Karachi National Highway, approximately 180 km north of Karachi and lying opposite to Thanobullah Khan. Different lithofacies of Laki Formation are defined on the basis of its characteristic features i.e. (1). Less fossiliferous micritic limestone facies (2). Pure white chalky limestone facies (3). Pink fossiliferous chalky limestone facies (4). Dark yellowish brown limestone facies. Laki Formation of Eocene age is mainly composed of massive to thick bedded pure white fossiliferous limestone, light pink to cream colored, medium to thick bedded, micritic and fossiliferous limestone. Dark yellowish brown, less fossiliferous lithofacies also exposed at some places. The petrographic analysis of samples reveals that rock consist of dolomite, calcite and grains/allochems. Silicicalstic sediments (quartz) and haematite occur as minor minerals in few thin sections. The microscopic texture is crystalline. Dolomite rhombs are clearly visible in thin sections and have been confirmed through staining techniques. The crystals shape of dolomite are euhedral to subhedral. The dolomitization is non-fabric selective, because they are replacing all components of the sediments in an indiscriminate fashion. Staining result shows that calcite occurs in relatively less amount. The crystal shape of calcite is usually anhedral. Grains/allochems include: foraminifera (especially Nummulite). Moreover dolomitization has partially replaced original shape of the fossils. The porosity types observed in thin sections include: intercrystalline porosity (due to dolomitization), intragranular porosity, and fracture porosity. Pores are interconnected at some places, which is a significant feature of reservoir rock. After petrographic analyses the rock samples are classified as “dolomite wackestone”, which shows low energy setting of deposition. Later on, diagenesis resulted in dolomitization. The diagenetic processes of dolomitization effectively replace the primary sedimentary structures, preserving minor detail, including fossil structures, allochems, and fine laminations. Lithofacies and petrographic analyses indicate that Laki Formation can be a potential reservoir of petroleum.

Segmental petrographic analyses of Kirana Hills shield rocks, Sargodha

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Abstract

The present study deals with petrographic analyses of some parts of the Kirana Hill rocks of Punjab plains, namely Buland, Hachi, Shaheenabad, Shaikh and Machh hills. On the basis of petrographic analyses, some corrections have been proposed in classification and nomenclature of rocks exposed in the above-mentioned areas. Chemical analyses have also been carried out in order to calculate CIPW norms and ultimately classification is done with help of "MAGMA SOFTWARE", to strengthen nomenclature scheme. Kirana volcanics represent the oldest remnants of widespread Precambrian bimodal igneous activity within the so-called Kirana-Malani Basin. Rhyolites predominate over the basalts/ dolerites, andesites, and phyllite/ slate. Rhyolitic rocks are light grey, greenish grey and light brown in color, aphanitic in nature. The observed microscopic textures are aphyric, phyric or porphyritic and micropoikilitc. Moreover, some rhyolitic rocks also show flow texture. They are either cryptocrystalline to microcrystalline or microcrystalline to cryptocrystalline. No glassy material has been observed in any thin section. Minerals observed in rhyolites during laboratory analyses are quartz, orthoclase, sericite, calcite/ ankerite, chlorite, hematite/ goethite, pyrite, iron (Fe) and minor amount of sodic plagioclase. Mafic rocks are characterized by the presence of chlorite, hypersthenes, augite and occasional olivine and ilmenite usually associated with plagioclase. Amphibole {hornblende, actinolite (uralite)} is also encountered in basalts/ dolerites. Andesites exhibit mainly porphyritic texture, but aphyric texture has also been observed in few samples. Phenocrysts consist of plagioclase laths of oligoclase to andesine composition and minor biotite in some samples. Its groundmass includes chlorite, quartz, sericite/ muscovite, hematite/ goethite, calcite, pyrite and iron (Fe). Hydrothermal alterations are also very common in these rocks. Two types of tuffs have been observed i.e. Lithic Crystal Tuff and Lithic Tuff. Other identified and classified rocks include basaltic Andesite, rhyodacite/ dacite, slate/ phyllite, ankeritic rocks/ veins and quartzofeldspathic veins. Although quartzite has been reported by Geological Survey of Pakistan in some of above mentioned areas of Kirana, in previous literature, but no evidence of quartzite has been found in the samples collected from these areas. The presence of iron (Fe) suggests magma from deep mantle instead of crustal melting / anatexis.

Application of petrophysical modelling of the eocene reservoirs in the Qadirpur area, central Indus Basin, Pakistan

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Abstract

The Eocene reservoirs of the Qadirpur field, Central Indus Basin are investigated petrophysically for their detailed reservoir characterization. The assorted petrophysical parameters determined include; true resistivity, shale volume, total porosity, effective porosity, density and neutron porosities, water and hydrocarbon saturation, bulk volume of water, lithology, gas effect, P-wave velocity and irreducible water saturation. The Eocene reservoirs are excellent with high effective porosity and hydrocarbon saturation, among these the Sui Upper Limestone in overall is a poor reservoir, though it has some hydrocarbon rich and much permeable intervals with a much better net-pay. The thickness of the reservoirs zones ranges from 20-130 m. These reservoirs are gas producing carbonates with almost irreducible water saturation and will produce water free hydrocarbons. The lower value of moveable hydrocarbon index shows that the hydrocarbons are moveable spontaneously to the well bore. The correlation model shows that the reservoirs have an inclined geometry and are a part of an anticlinal trap.

Petrology of the Naweoba block of Zhob ophiolite, Northern Balochistan, Pakistan

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Abstract

In northern Balochistan Pakistan, the Zhob Valley ophiolites comprise of the Muslim Bagh, Khanozai and Zhob ophiolites. The Zhob Ophiolite is divided into three detached blocks; Naweoba, Jizha and Ali Khanzai. This study reports the petrology of Naweoba block; the largest and well exposed block of Zhob Ophiolite. The Naweoba block is bracketed between the sediments of Indian plate passive margin at the base and the sediments of the Flysch belt at the top. The block is mainly composed of mantle peridotite, crustal gabbros and the underlying basalts-chert unit. The mantle rocks are mainly foliated peridotites which are partially to completely serpentinized and tectonically deform. The rock types identified in petrography are lherzolite, harzburgite, dunite, wehrlite and pyroxenite. Lherzolite is mainly composed of olivine, clinopyroxene and orthopyroxene with spinel and opaques, while, the constituent minerals of harzburgite include olivine, orthopyroxene with minor clinopyroxene and spinel. Both the lherzolite and harzburgite are medium to coarse-grained and generally granular to sub-equigrainular in texture. Dunite mainly consists of olivine with minor pyroxene and spinels. It is generally fine to coarse-grained and holocrystalline in texture. The veins and dykes of wehrlite and pyroxenite are found in the upper part of the mantle section. Wehrlite is fine to medium-grained, consists of olivine, clinopyroxene, and orthopyroxene and the accessory spinel with granular interlocking to hipidiomorphic in texture. Pyroxenite is medium to coarse-grained and predominantly consists of clinopyroxene with minor orthopyroxene and olivine and opaques. The crustal section of the Naweoba Block comprises of gabbroic rocks only. The Gabbros are both layered and massive in nature and are highly deformed and in structural contact with surrounding lithological units. Petrographically, gabbros are divided into gabbro, norite, and hornblende gabbro. They mineralogically consists of plagioclase, pyroxene and hornblende with minor olivine and opaques. The secondary minerals identified are chlorite, epidote and serpentine. The Basalt in Naweoba Block covers a large area. It surrounds peridotite and gabbro and is in thrusted contacts with them. The basalt is mainly pillow, sheet and tube like in structures and is intercalated with chert and minor mudstone and limestone. At some localities the chert has thick separate units, forming prominent hills in the area. The chert is red, green, cream and grey in colours. Basalt has showings of copper, iron, and manganese. Mineralogically, basalt consists of altered phenocrysts of plagioclase and augite embedded in micro-crystalline groundmass of plagioclase, augite, and magnetite. Basalt shows aphanetic, porphyritic and subophitic textures. The mantle section of Naweoba block is dominated by the harzburgite with subordinate dunite; they are interpreted residual after significant melting, while, the wehrlite and pyroxenite are possibly formed by magmatic processes. The gabbroic rocks are developed by in situ fractional crystallization at the floor of magma chamber. Field and petrographic characteristics of the mantle to crustal rocks of Naweoba Ophiolite and the underlying basalt-chert unit are nearly similar to that of the Muslim Bagh Ophiolite Complex found in the south of Zhob Ophiolite. It can be interpreted that the Naweoba block of the Zhob Ophiolite may have been formed in the same tectonic setting as the Muslim Bagh Ophiolite Complex.

Velocity and structural modeling of Chiltan Limestone and Goru Formation for hydrocarbon evaluation in Bitrisim Area, Lower Indus Basin, Pakistan

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Abstract

The present study focuses on building a workflow for structural interpretation and velocity modeling and implementing to Jurassic-Cretaceous succession (i.e., Chiltan Limestone, Massive Sand of the Lower Goru Formation). 2D-Migrated seismic sections of the area are used as data set and in order to confirm the presence of hydrocarbons in the study area, different types of seismic velocities and physical properties of rocks from multi-component seismic data are estimated.

Few specific issues in the use of seismic data for modeling and hydrocarbon evaluation include distinguishing the reservoir and cap rocks, and the effects of faults, folds and presence of hydrocarbons on these rocks.

The study of structural interpretation and modeling of the seismic data have been carried out for the identification of traps. The results demonstrate that appropriate structural traps in the form of horst and grabens in the area.

2D and 3D velocity modeling of the horizons of the Goru Formation and Chiltan Limestone indicate the presence of low velocity zones in the eastern half of the study while relatively high velocity zones are encountered in the western half of the area. These velocity variations have both lithological and structural controls on them. Two wells are drilled in the study area (i.e. Fateh-01 and Ichhri-01) and both are dry. Immature hydrocarbons migration is considered as a failure reason for Fateh-01 and Ichhri-01 well.

Appraisal of biostratigraphic techniques at subsurface

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Abstract

The accurate and timely identification of the rock units during drilling has paramount positive economic outcomes particular if the problem arises in deciding the terminal depths. Sometime the terminal depths are decided before the actual target is approached due to the miss identification of the stratigraphic units. The structural disturbances and lateral facies variations within the sub-surface are the major causes of stratigraphic problems which may hamper the effective decision making.

The use of biostratigraphy for the identification of the stratigraphic units, demarcation of the subtle stratigraphic traps, and reassessment of the burial history by identifying the missing biozones, enhances our capabilities for a successful hydrocarbon exploration.

In this study, we have used the biostratigraphic techniques to identify the stratigraphic sequence and making the terminal depth decisions possible. The age diagnostic smaller and larger benthic foraminifera, pollen, spores and dinaoflagellates have successfully been used to identify the Cambrian, Permian, Mesozoic and Tertiary rocks of the Indus Basin.

Gemstone resource potential: A key component in rebuilding the Pakistan natural resource sector

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Abstract

Gemstones exploration, mining, cutting, testing and marketing make the building block of the gemstone potential, the back bone of a country's natural resource. The Himalayan and Karakoram mountain ranges in North Pakistan are known to host emeralds, peridots, rubies, tourmalines, topazes and aquamarines. These gemstones are formed by metamorphic processes and hydrothermal activity. Emeralds occur in talc-carbonate schists in Swat valley and peridots in the Sapat valley of District Kohistan. Rubies occur in calc-silicate marbles in the Nangimali of Neelum valley in Azad Jammu and Kashmir and Naran area of KPK, and at Hunza and Nagar valleys of the Gilgit-Baltistan province.

It is quite known that every naturally occurring gemstone has its own signatures. For example the presence of Cr, V, Be, Li, Sr and La in talc-carbonate schists lead to explore emerald mineralization. Magnetite may be taken as pathfinding mineral for peridots. Phlogopite, fuchsite and pyrite minerals may indicate ruby mineralization. Tourmalines, topazes and aquamarines occur in complex pegmatites. The criteria to explore gemstones in complex pegmatites include the study of Rb, Ba, Nb, Ta, Sn, Li, Cs, Mn and Mg concentrations in muscovite.

The gemstone mining in Pakistan has been remained slow and steady. To date mining is done in a primitive manner. Gemstones are extracted using hand picks, crow bars, shovels, drilling machines and dynamite. These techniques usually damage the gemstones and yield low production. Crude techniques and remoteness make the mining very hard. Because of these difficulties the private sector in Pakistan is facing problems for extracting enough quantity of gemstones. Pakistan is also a source of good quality gemstone specimens. Many specimens from Pakistan can be found at gems and mineral shows and for sale on the Internet. Pakistan has a great opportunity to increase its share of this market and to meet the increasing demand for higher quality gems worldwide. The gemstones need to be cut and polished to excel their beauties before trading in the market. In Pakistan cutting and polishing industry is based mainly on entrepreneurship. The quality of cutting and polishing always remained hardly meet the international standard due to lack of state of the art equipment resulting in less export in cut and polished gems and the gemstones studded jewelry.

In the present gemstone scenario, a significant quantity of cut and polished gems in the markets are synthetic and fake. Proper laboratory tests separate the real gems from synthetic and fake gems. In the international markets, the availability of the data about the size and scope of gemstones is very limited, because of less sharing of the data due to private business. There is constant shift in the global trade of gemstones due to rapid change in the demand for shapes, cuts, colours and type of gemstones. Asia still being the centre of gemstones has strong influence on the world trade. At present the world trade for coloured gemstones is dominated by Thailand, Switzerland and India.

To come up at the international level, there is an utmost need to up-grade this sector so that a sustainable growth can be achieved in the economic development of Pakistan's natural resource potential. This economic rebuilding will provide a new hope to the national and international business and mining communities to invest more and to serve as a foundation for future work on areas of gemstone resource potential and to attract Foreign Direct Investment (FDI) in the Gemstone Sector of Pakistan.

Origin of the Permo-Triassic Swat-Chakdarra granites in the higher Himalayan region of Pakistan: I- or S-type granites

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Abstract

The Swat-Chakdarra granites are exposed in the higher Himalayan region of Pakistan. The granites of the area are metamorphosed into augen gneisses comprising of quartz, feldspar, muscovite, biotite ± garnet. These granites are mainly subalkaline and peraluminous. These are enriched in large ion lithophile and light rare earth elements. Using REE patterns, the granites show prominent depletion in Eu, suggesting fractionation and/or early crystallization of plagioclase. The Chakdarra granites yield Rb-Sr whole-rock isochron age of 213 ± 24 Ma whereas the Saidu-Paroona and Illum-Karaker granites of Swat area illustrate 285 ± 8 and 260 ± 52 Ma ages, respectively. The $\delta^{18}O$ values in Chakdarra, Illum-Karakar and Saidu-Paroona granites are +8.8 to +9.2‰, and +8.6 to +9.4‰ and +9.0 to +9.5‰, respectively. These granites show less than +10‰ $\delta^{18}O$ values, suggesting their I-type origin, however, the mineral assemblage and peraluminous chemistry classify the granites as S-type. Therefore, we conclude that the Permo-Triassic Swat-Chakdarra peraluminous granites with less than 10‰ $\delta^{18}O$ values are the W-type (White, A.J.R -type) granites, which were formed by fractional crystallization process from I-type crust rather than partial melting of the continental crust and/or crustal contamination, i.e. C-type (Chappell, B.W -type) granites. Based on the geochronolgical data the Illum-Karakar, Saidu-Paroona and the Chakdarra granite gneisses may belong to Permo-Triassic magmatic events resulted fom rifting of the Gondwanaland.

Preliminary flood inundation estimates using CREST hydrological model: Case study of Mangla subwatershed of Indus River System Simulation using GIS and RS Technologies

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Abstract

Flood of 2010 in the Indus Basin has devastated the already weak agrarian economy and caused enormous damage to life and property in arid to semi-arid Pakistan. There is a dire need for research in the water sector and in flood early warning system. In the absence of a widespread on-ground coordinated precipitation and water discharge monitoring system, water resource management and risk management systems, typically multidisciplinary tasks, geographic information sciences (GIS) and satellite remote sensing (RS) technologies can play a key role in providing innovative information to decision makers through research. GIS and RS technologies offer state of the art innovative insight not only into urgently needed sustainable water resource management and into near-real time flood disaster risk assessment, forecasting, management, and damage reduction strategies.

This paper attempts to use NASA's Tropical Rain Measuring Mission (TRMM) daily rain estimates, and global evapotranpiration estimates as major forcing in calibrating CREST hydrologic model with the in-situ daily river discharge data from Mangla subwatershed. The Nash-Sutcliffe Coefficient of Efficiency (NSCE) of 0.49 was achieved with a correlation coefficient of 0.70 and a bias of 1.17%. Improvement in the prediction of available water resource as a result of monsoonal precipitation and water discharge from the Mangla and other major subwatersheds of the Indus River System is on-going. The results indicate that the CREST model behaves well with the TRMM rain estimates in simulating surface runoff in general, but ignores the snow melt contribution to the discharge. Improvement in the NSCE through tweaking various empirically adjusted parameters will help in the prediction of flood hazards, riverine as well as flash flood hazards – possibly in the form of establishment of a pre-disaster information system and a coordination strategy to cope up with expensive natural disasters, and a shift in preparedness strategy from post-disaster rescue and relief to pre-disaster early warning and early action.

Radon gas in the environment: A terrific mate or horrific rival?

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Abstract

The noble gas radon (^{222}Rn), found ubiquitously in our environment, is a colorless, odorless and tasteless entity. It is a dangerous alpha particle (^{4}He) emitting gas and behaves both as an excellent friend and as a worst enemy of mankind. It is generated on account of radioactive breakdown of its instantaneous parent Radium (^{226}Ra) in the Uranium (^{238}U) decay series found in trace amount in soils, rocks and water.

In living places and underground excavations its highly charged solid daughters attach themselves to air borne dust particles, which are subsequently dumped in the pulmonary tract after inhalation, thus creating a threat of lung cancer to human health. Similarly, ingestion of radon bearing drinking water can also cause a threat of gastrointestinal cancer. Several thousand people throughout the World expose themselves yearly to radon dose in the facilities ranging from rural old mines, to expensive sanatoriums and clinics in the hope to get rid of their body pains. Radon baths are characteristically used for high blood pressure, joint pains and arteriosclerosis of lower margins, and inhalation treatment is frequently managed at speleotherapy centers for conditions such as bronchial asthma and chronic bronchitis.

Therefore, on one hand radon gas is considered as a serious health risk to mine workers and common people living in their homes, while, on other hand it is a very valuable tool in a wide variety of human applications including therapeutic usage in medical sciences and utilization as an exploratory tool in earth sciences. As a geological tool radon monitoring technique can be used in mineral exploration, prediction of future earthquakes, study of active geological faults and geothermal energy sources. Fault zones have been recognized with fairly precise accuracy throughout the World with this technique. The tool can also successfully be used in hydrologic research, when studying the interactions between streams, groundwater and rivers. It has also found limited use in search for geothermal energy sources.

Use of GIS in water resource projects –Baz Ali small dam: A case study

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Abstract

Computers have become a paramount for modern day advanced and complex mathematical and analytical modeling. Geography has evolved into GIS, the Geographic Information Systems, which is a combination of software and hardware. GIS is used as a modeling tool to analyze complex data related to diverse fields; from archeology to zoology (A to Z).

Application of GIS is evident in the fields of engineering, especially in civil engineering projects where physical survey of the site becomes mandatory. Many projects are delayed or even fail in the initial feasibility stages due to logistics and financial constraints.

Full advantage of advancements in GIS can be utilized by engineers and experts in geospatial science by gathering the required data through satellites, modeling and analyzing it without physically going to the site. Therefore, GIS can be used for preliminary studies like site selection to modeling complex flood and water runoff analysis.

This research presents a case study of Baz Ali small dam situated in Kurram Agency, FATA. The findings of physical investigation of the site were compared with geospatial data (that is, GIS and remotely sensed data). The results show that GIS can be fully used for site selection and carrying out preliminary study for feasibility of water resources and conservation projects. Various parameters like contour plotting, catchment area, length of main stream, and alike can be worked out without physically investigating the site.

Lithostratigraphic mapping and modeling of Bara Nala, Sindh, Pakistan

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Abstract

Pab Sandstone as a potential reservoir in Bhit and Zamama gas field, trigger to carry out the study in Bara Nala section which is of great stratigraphic significance being the only locality in the Southern Indus Basin where Upper Cretaceous to Pleistocene succession can be studied. The structure of the Bara Nala section is an anticline fold, is pitching in both directions (north and south) forming domal anticline. Comparison of the outcrops on both flanks of the anticline suggests probably two major faults. Lithostratigraphic modeling shows that the Hemipneustes Limestone (Moro Formation) is the lowest exposed bed in the area with thickness of 10.3m. The Pab Sandstone is medium to fine grained with cross bedding and ripple marks generally absent in the lower part where as they are prominent in the middle part. The shallow marine to fluvio-deltic environment shows short lived transgressive events with multiple coarsening upward cycles. The maximum thickness is 250m in Bara Nala where as in Khadro Nala its 219m. The Ranikot group contains Khadro and Bara Formation. The *Cardita beaumonti* bed overlies the Pab sandstone with 12m thick Basalt /Trap, equivalent to Daccan trap containing 3 individual flows with maximum thickness of 3.5m. The Bara Formation contains sandstone with variegated color, ripple marks and cross bedding with thickness varies from 50 to 65 m. The Laki limestone is well jointed and highly folded exposed as prominent scarps with dip more than 80^{o}. The thickness of Laki limestone, Tiyon and Manchar Formation is 121m, 52m and 86m respectively.

The remedation of landslide at Jhika Gali, Murree

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Abstract

A site at Jhika Gali was earmarked for a 13 storey car parking plaza in the year 2008, to ease the traffic problem in the resort town of Murree. However, the haste to start work on the project prevented due diligence and execution of proper geotechnical investigations beforehand. Landslides triggered during foundation excavation at about 120 ft. depth below the road level in the steep natural slopes. The sliding revealed the area to contain an old dormant landslide as well.

Subsequently, the parking plaza was halted and a series of geotechnical investigations and studies were carried out. It was concluded that not only the area was unsuitable for placing a multi-storey structure at this location but also that it required stabilization measures to save the existing road network from any future landslide activity.

The stabilization measures adopted included construction of massive Reinforced Earth work using Terratral T-2, cast insitu bored pile retention system at the toe, extensive surface and sub-surface drainage measures and stabilization of unstable area downhill.

Lessons learnt include that the extensive investigations are a must before the start of projects in areas prone to landslide activity.

A comparative study of fossil vertebrates from the Siwaliks at Garhiyala village, District Attock, Pakistan

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Abstract

Siwalik deposits of Pakistan possess a large number of well-preserved vertebrate fauna bearing the typical morphological features. The overall dental morphology was identified and measurements of the dental constitution were documented to trace back the fauna obtained from the Siwalik deposits exposed in Garhiyala village in District Attock to the species level. The height to width (H/W) values of the dental constitution were determined to categorize the specimens between extremely brachyodont (<50) and extremely hypsodont (>120), while width to length (W/L) indices were used to identify the grade of the crown between extremely narrow crowned (<50) and extremely broad crowned (>125). A total of three species were diagnosed identifying the specimens collected from the Siwalik deposits. First specimen represents the mandibular part of *Selonoportax vexillarius* with three molars and one premolar preservd; all these are extremely hypsodont and narrow crowned. The second specimen is the maxillary part of *Proamphibos kashmiricus* with four hypsodont and narrow crowned molars and one extremely hypsodont and extremely broad crowned premolar from the Upper Siwalik conglomerate of the Pleistocene Soan Formation. The third specimen has been identified as mandinle of *Antilope subtorta* with two extremely hypsodont and narrow crowned molars and one extremely hypsodont and braod crowned premolar. Both the first and third specimens were collected from the sandstone of the Middle Siwalik Dhok Pathan Formation of Early to Middle Pliocene age.

Hydrocarbon generation potential and depositional environment of the Cherat coal, Khyber Pakhtunkhwa, Pakistan

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Abstract

The coal from Paleocene Hangu Formation is evaluated for hydrocarbon generation potential, using optical microscopy and geochemical analysis. The kerogen type identified is dominated by type-III and maceral type by vitrinite, with collinite being dominant sub-group. The >2% TOC values suggest a promising source of the coal for hydrocarbon generation with the highest TOC value (>76%) recorded in coal sample SK-4 and the lowest (7.02%) in coal sample DG-1. All the coal samples show good to very good values (>6%) of generation potential (GP) with highest value 59.68 in sample SK-4 and lowest 6.3 in DG-1 HI versus T_{max} plot indicates that coal samples are post mature. However, the vitrinite reflectance values (Ro) range from 1.03% to 1.26%, showing late mature stage. OI is continuously low throughout the analyzed interval, which further supports that coal is of good quality and is gas prone. Based on the maceral types and Rock-Eval data, anoxic to terrestrial environment is inferred for the deposition of this coal. All these parameter show that the coal is of good quality (i.e. bituminous grade), mature and lying in gas window. It has also been confirmed with the rock maceral analysis through visual recognition. Most of the pre and post-Paleocene coals in Pakistan are not of good grade since they contain more water content, but in this case the water content is negligible. The Paleocene Hangue Formation is present both on surface and in the subsurface throughout the Kohat sub-basin and thus can be regarded as a potential candidate for coal bed methane, unconventional gas and as well as carbon sequestration.

Structural investigation and geological mapping of Juna and Jhawala area, Kotli, Azad Jammu and Kashmir

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Abstract

The areas of Jhuna and Jhawala were investigated to get detailed insight into their structural makeup. Being sandwiched between Jhelum Fault to the west and Himalayan Frontal Thrust in the east, the structural style of the area is controlled by the two. The Middle to Late Miocene Chinji and Late Miocene Nagri formations covering the surface area of the mapped area are involved in folding and faulting. The structural fabrication of the area is composed of northeast – southwest verging or northwest – southeast trending gentle to open folds and a reverse fault, depicting a northeast - southwest compression. The general trend of the mapped structures is collinear with the anti-clock wise rotation of the Hazara Kashmir Syntaxis and the sinistral movement along the Jhelum Fault.

Development of Kutwall Lake as indictor of changes in dynamics of Mani Galcier, Haramosh

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Abstract

The glaciotectonic processes are effective landscape architectures in the glacier valleys. The variation in glacier movements creates environment of folding structures in moraines and influence bedrock materials. The surging of glacier develops folding waves in end moraines. In case of retreat of glacier area between end moraine and snout turns into Glacier Lake. The development of Kutwall is typical example of Mani glacier changing dynamics. The end moraines wave structure illustrates the surging glacier which is converted into distributary at Kutwall Lake. The present Mani glacier lateral moraine working as embankment between glacier and lake allows suggest scenario of development of Kutwall Lake which reflects dynamics of Mani Glacier. The end moraine folds were developed during advancing of Kutwall glacier (Now distributary).The younger Mani glacier surging perpendicular to Kutwall glacier force it to change direction of flow and convert into distributary. The observation of change axis of fold waves from perpendicular to parallel in ice of Kutwall glaciers supports above mentioned scenario. The lateral moraine of younger Mani glacier became embankment of Kutwall Lake. The melting of ice between lateral moraine of Mani glacier and Kutwall glacier end moraine form Kutwall Lake. The above mentioned scenario of glaciotectonic dynamics of Mani glacier determine importance of role of gravitational force in the Mani glacier which converting small glaciers in to distributaries. However, the isotopic studies of Kutwall lake water, Mani glacier and Kutwall glacier distributary and composition and age identification of lateral moraine sediments of Mani and end moraine of Kutwall glaciers will prove or reject above mentioned hypothesis about development of Kutwall Lake.

Mineral resources of Sindh Province, Pakistan

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Abstract

The Sindh Province includes Kirthar Basin and southeastern part of Sulaiman Basin. Iron, laterite and ochre reported from Lakhra, Meting and Makli hills, Nagar Parker, Jhal Dhand, Sohnari Dhand and Noriabad; Nari Formation and in Manchar/Vihowa group in the eastern Kirthar foldbelt; celestite from Thano Bula Khan; tungston/sheelite, gold and other heavy mineral concentrates (magnetite, ilmenite, garnet, epidote, zircon, tourmaline, amphibole/hornblende and tremolite, apatite, pyroxene, etc) from placer in the Indus River and mollase rocks like Vihowa group, Manchar group and recent sea; zircon from the shore areas, gold (can be explored) from Nagar Parker; alum from pyritiferous shales of Gajbeds from Maki Nai, shales of Ranikot group and Nari/Gaj group and at Shah Hassan near Trimi. Alum, Trona (source of Na) and potash slats associated with rock salt deposits and lakes in the vicinity of Sind coast; gypsum from Miocene Gaj shales near Johi and K.N.Shah, Dadu district and nitrogen from air. Various Ceramic Mineral Resources/clays found from Laki, Kirthar and Vihowa/Manchar groups; China clay from Nagar Parkar and Islamkot Thar, Dhed Vero, Parodhoro, Karkhi, Dungri, Motijo, Vandio, Ramji-jo-Vandio, and Didwa-Surachand areas; fuller's earth from Thano Bulla Khan (Dadu district) and Shadi Shahid (Khairpur; near Jheruk and Rohri and at Begamji; fire clay from Dadu district, Sohnari Dhand/Jhimpir; Laki group, Ranikot group and Vihowa/Manchar group of eastern Kirthar Foldbelt; orthoclase feldspar from Nagar Parkar; silica sand from Meting to Jhimpir railway stations and in Eocene and Oligocene strata near Thano Bula Khan in Dadu district and Jangshahi deposits; cement industry raw materials and calcite veins in limestone of different age; pyrite is disseminated in carbonaceous shale and coal; abrasives type red ochre in Eocene Sohnari beds, nodular flints between Rohri and Kot diji; in west of Jhol Dhaund, around Harmon Mohatta coal mine west of Sohnari Dhand (west of Jhimpir), west of Ongar Jhol Dhand (north of Thatta) and Sohnari 15km east of Jhimpir; Grity Pab sandstone of Khadro and Bara areas (can be used for abrasive purposes); Quartz deposits of Cretaceous Pab Formation from eastern slope of Lakhi range district Dadu; Radioactive Mineral/uranium Resources from fluviatile cross bedded sandstones/placer of Vihowa/Manchar group; Coal Resources from Thar, Lakhra, Badin, Sonda-Thatta, Meting-Jhimpir; large Construction stone, dolomite and Industrial rocks Resources from Jurassic to Eocene sequences in Kirthar and Lakhi ranges, Thar and Cholistan desert; granite and other Igneous along with some metamorphic rocks from Nagar Parker, large Water resources in alluvial and bed rocks, and gemstone like agate and chalcedony from Nagar parker, chert, flint and Jasper from Vihowa group/Manchar group from eastern Kirthat and Lakhi range and other areas. The Natural Resources like the minerals, coal, oil, natural gas, etc are non-renewable resources while the solar, air/wind, terrestrial water, marine water/ocean, tides, waves, current, land, biomass, etc are renewable (recycled) resources. It is our urgent need to convert the non conventional energy resources into conventional energy resources. Our land is receiving huge amount of energy from sun. The coastal areas have high potential of wind energy. Gravitational force of moon produces tidal energy in sea which can be converted in energy by the construction of dams which can store water at high tides and release water at low tides. Sindh has a long sea shore from Nagar Parker to west of Karachi. Energy from sea waves can also be benefited by stable and non stable plate's movements. Sindh also has a large waste biomass.

Mineral and gemstone resources of Azad Kashmir and Gilgit-Baltistan (Pakistan)

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Abstract

The northern Indus Suture and Shyok Suture and adjacent areas, and major faults with high shear density in Karakoram, Kohistan and NW Himalayas are the main target areas for minerals and gemstones exploration. The Azad Kashmir includes bauxite, laterite and ochre from Muzafarabad, Kotli and Reshian regions (disconformity); copper, gossan/red iron oxide/ochre and graphite from Neelam river; sheet mica/muscovite and lithium mica/lipedolite from many pegmatites of Neelam valley; uranium in grphitic schist of Precambrian Salkhala Formation found in Reshian region ESE of Muzafarabad; nephlene syenite from Reshian region, coal from Kotli region and limestone and marble from different areas. The reserves of bauxite, laterite and ochre are Dhanwan (alumina 41-60%, silica 18-40%, iron 1-8%) is 4.9mt, Kamroti (alumina 50-70%, silica 9-28%, iron 1-2.5) is 1.36mt, Sawar (alumina 52-56%, silica 25%, iron 5%) is 0.93mt, Dandili (alumina 34-46%, silica 36-44%) is 1.18mt, Nikial (alumina 41-46%, silica 13-35%, iron 2-27%) is 0.424mt, Goi (alumina 47%, silica 35%) is 1.103mt, Shisetar is 0.656mt, Bermoach (alumina 51%, silica 23%) is 0.2mt, Balmi (alumina 46%, silica 31%) is 0.209mt, Khandar Karela is 0.209mt and Palan is 0.283mt with total 11.454mt. Azad Kashmir represents many gemstones from Neelam valley like orange-red spessartine garnet (large crystals) in pegmatites, ruby from Nangimali-Khora-Katha-Chitta Ratta and Naril Nala areas in metalimestone and calcite veins, green tourmaline from Donga Nar pegmatites, black tourmaline (schorl) and quartz from different gem localities.

The Gilgit-Baltistan Province includes arsenic (arsenopyrite, chalcopyrite, malachite, pyrite) from Dainyor Nala (15km NE of Gilgit) and Bagrot Nala (20km N of Gilgit); bauxite from Chapursan (Hunza); copper and gold associated with gossan/red iron oxide/ochre and base metals of Karakoram and Shyok Sutures like Dainyor Nala (NW of Gilgit), Barit, Bulashgah (also magnetite pod in ophiolitic rocks), Majadar and Bor Nala, and Bagrot Nala, Henzil (10km NW of Gilgit), Sher Qila (33km NW of Gilgit), Singal (45km NW of Gilgit), Nazbar valley (22km W of Yasin), Shigari Bala area of Skardu and Golo Das and surrounding areas, iron from Indus Suture and its vicinity areas like Chilas, east of Gilgit, western, northern and eastern part of Hamosh massif forming lobe; lithium/lepidolite from Shengus of Nanga Parbat Massive (numerous pegmatites intruded in gneissic rocks); sheet mica/muscovite from many pegmatites like Astor, Bagarian and Hawa Gali; uranium from many areas; graphite from Nagar Hunza, Chalt and Chelish; and widely exposed limestones and marbles from different areas; and coal from Chapursan valley. The Gilgit-Baltistan represents many gemstones like aquamarine from Askere, Shingus, Dusso and Tisgtung of Gilgit; emerald from Khaltaro of Gilgit; moonstone from Shingus and Bulechi (Gilgit); quartz from Gilgit and Skardu; red ruby and spinel (magnesium aluminate; from hunza are more attractive than Burma), and pargasite cabochons (green amphibolite; locally purchased as Hunza emerald) from Hunza valley; rose quartz from Dusso pegmatites near Skardu; topaz from pegmatites from Bulechi, Shingus and Gone near Dusso in Skardu; gem tourmaline (pink, blue, green and black) from pegmatites of Haramosh Range like Stak Nala between Gilgit and Skardu, Bulechi and Shingus; beautiful pyrite, malachite and azurite in pegmatite near Gilgit.

Revised stratigraphy of Balochistan Basin, Pakistan

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Abstract

The Balochistan basin is subdivided into Chagai-Raskoh-Wazhdad magmatic arc, Kakar Khorasan (back arc) and Makran (fore arc; arc-trench gap) basins. The revised Stratigraphy of Kakar Khorasan basin includes Cretaceous-Paleocene Nisai Group (=2000m thick) comprises of Akhtar Nika Formation (alternated limestone and shale; 1000-1500m thick), Jabrai Formation (mudstone/shale with alternation of thin marl/limestone beds; 500-1000m thick) and Nisai Formation (mainly two massive limestone unit separated by shale unit; 100m thick), Paleocene-Eocene Shagala Group consists of Murgha Faqirzai Formation (shale, 2000m thick), Mina Formation (alternation of green shale unit and sandstone unit; 3000m thick) and Shagala Formation (=Shagalu; alternation of terrestrial red shale unit and sandstone unit; 3000m thick), Oligocene-Pliocene Vihowa Group (synonyms; Malthanai/Dasht Murgha group) represents Chitarwata, Vihowa, Litra and Chaudhwan formations and Pleistocene-Holocene Sakhi Sarwar Group (Boston formation) represents Dada and Sakhi Sarwar Formation (mud and sandstone with poorly developed conglomerate, while in centre of valleys the mud is dominant) concealed at places especially in the valleys and plain areas by the Subrecent and Recent fluvial, eolian and colluvial deposits. The Nisai Group is correlated with Early Cretaceous Parh Group, Late Cretaceous Fort Munro Group and Paleocene Sangiali Group (Sangiali, Rakhi Gaj and Dungan formations) of Sulaiman basin. The Shagala Group is correlated with Chamalang (Ghazij) Group and Kahan Group of Sulaiman basin. The southern part of Kakar Khorasan basin shows flysch deposition like Murgha Faqirzai Shale and Mina Formation (green shale and sandstone) while the northern part of Kakar-Khorasan basin shows both these formations as flysch deposition while the middle-Late Eocene Shagala (Shaigalu) Formation (sandstone and red to maroon, brown shale and sandstone) as terrestrial/molase deposits which is supported by continental rhinoceros-baluchithere mammal fauna. The Chagai-Raskoh-Wazhdad magmatic arc shows the Cretaceous Chagai intrusions which is invaded by Sinjrani Volcanic Group (=Kuchaki), Cretaceous-Paleocene Nisai Group includes Akhtar Nika and Jabrai formations (Synonyms; Humai and Rakhshani formations and Nisai Limestone (Synonyms; Robat/Kharan/Wakai limestones); Late Paleocene-Early Eocene Shagala Group includes Murgha Faqirzai and Mina formations (synonyms; Khojak/Saindak/ Washap/Amalaf formation), Late Eocene Shorkoh intrusions, Washuk Intrusions (granite exposed in the southern part of western Washuk range), Wazhdad Volcaniclastics Group and Washuk ophiolite, Oligocene-Pliocene Pishi Group (=Vihowa group), Middle Miocene Buze Mashi Koh volcanic group, Late Pliocene to Pleistocene Koh-i-Sultan Volcanic Group and Pleistocene-Holocene Sakhi Sarwar (Kamerod/Boston/Kech) Group, Subrecent and Recent fluvial, eolian and colluvial deposits. The Makran basin show the Cretaceous-Paleocene Nisai Group includes Akhtar Nika and Jabrai formations (Parh like limestone near Mand) and Nisai limestone (Wakai limestone), Late Paleocene-Early Eocene Shagala Group includes Murgha Faqirzai Shale (Siahan shale, Zurati shale and sandstone; Hoshab shale), and Mina Formation (Panjgur sandstone and shale), Oligocene-Pliocene Talar (=Vihowa) Group (Parkani mudstone, Talar sandstone and Chatti mudstone), and Pleistocene-Holocene Sakhi Sarwar Group.

2D seismic interpretatioin using reflection method for hydrocarbon evaluation of Tajal Area, Sindh

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Abstract

The research work pertains to investigate the 2D seismic interpretation for Hydrocarbons evaluation using reflection technique, as seismic reflection is quite result oriented method to explore hydrocarbon potential. To carry out this exercise, seismic reflection data, which consists of line TJ-90 of Tajal area situated in Lower Indus Basin is taken. The data passed through a desirable processing sequence and finally a time section was prepared. The reflectors were marked as R1, R2, R3, R4 and R5, and after correlation with stratigraphic sequence encountered in Kadanwari Well 08, these were named as Lakhi, Ranikot, Upper Guru, Lower Guru and Chiltan formation.

Chiltan Formation is main reservoir and productive in the area. Study area is mainly characterized as extensional regime (normal faulting). Faults were also marked to examine the subsurface structure. Due to the extensional regime horst and graben geometries are present in the area, favorable for the accumulation of hydrocarbons. The subsurface picture of the area shows the smooth trend of strata dipping gently from east to west direction, thinning of strata is going to take place from east to west. Time and Depth contour maps are also prepared at a particular level to analyze the variations on the basis of time and depth. Iso Velocity maps were prepared to determine the variations of velocity.

Using well data of Kadanwari Well 08, Synthetic seismogram was generated and then correlated with the depth section, which further confirmed initial interpretation. In addition to this the rock properties are also calculated using this data; special concentration was on the porosity of the rocks which further confirmed the reservoir potential of Chiltan formation.

WAPDA micro seismic monitoring system in Northern Pakistan
Seventy-five months of recording around Diamer-Bhasha Dam project

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Abstract

Northern Pakistan is placed at the edge of Indian plate that continuously move under the Eurasian plate making the region highly susceptible to seismic activities. The mechanism has triggered a few great and several intermediate earthquake in a band of about 50-80 km width and an arc length of about 2500 km. Due to the availability of feasible water traps, Pakistan WAPDA is going to construct many large Dams and Hydropower structures like, Bunji (7100 MW), Diamer-Basha (4500 MW) and Dasu (4300 MW) in such an active tectonic environment. As per ICOLD recommendations. The Micro Seismic Monitoring System (MSMS) at least five years prior to the construction have been installed. The WAPDA MSMS consists of 29 six components seismic stations installed along the known active faults that are running close to the large Dams and Hydropower structures. All the stations are transmitting recorded seismic data through satellite link to its Central Recording Station (CRS) located at Tarbela Dam Project. At the CRS processing, analysis and cataloguing is carried out by the latest state of art Antelope Software.

Diamer Basha Dam with its 272-metres in height will be the highest RCC gravity dam in the world. It will be situated on the Indus River, about 315 km upstream from the Tarbela Dam site and about 40 km downstream from Chillas. It is designed to form a large reservoir on Indus River with an active storage of 6.39 MAF. The second purpose of the Project is to generate hydropower that will be accomplished through two power houses, one under each bank, with a total installed capacity of 4500 MW. Through three detailed Seismic Hazard Evaluations (SHE) and several seismotectonic studies it has been concluded that horizontal Peak Ground Acceleration (PGA) for Operating Basis Earthquake (OBE) = 0.22 ‘g’, Maximum Design Earthquake (MDE) = 0.37 ‘g’ and Maximum Crediable Earthquake (MCE) = 0.46 ‘g’. Seismic Safety Monitoring of Dam site and surrounding areas started in September-2007 with the installation of ten WAPDA MSMS stations. By the end of December-2013 the MSMS has completed seventy-five months of microseismic monitoring. A developed map of 50 km radius confirms the existence of seismic sub-zones and fault near the Project, with seismicity mostly confined at shallow depths. However, the seismic events are micro in nature and the seismicity remained in the moderate level during the seventy-five months of monitoring period.

Revised stratigarphy and structural interpretations of a part of the Samana-Khyber Ranges, NW Pakistan

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Abstract

This study presents the first geological map on 1:50,000 scale of the southern margin of the Khyber Agency and covering part of the northeastern Orakzai Agency, Survey of Pakistan topographic sheet No 38 O/1. The area was previously mapped on 1:250,000 scale by Meissner et al. (1973) with the help of aerial photographs and limited field traverses. Meissner correlated the northern part of the quadrangle with the rocks of the Attock-Cherat range situated in the east of the mapped area. The Precambrian rocks, undivided Jurassic rocks with the unconformable and or faulted contact with overlying Miocene Murree formation and undivided Paleocene rocks in the vicinity of Bara River were mapped in the northern part of the quadrangle. In the southern part of the area along the Mastura River the Cretaceous rocks were shown over the undivided Jurassic rocks.

The stratigrahic setup of the area reinvestigated in this study highlights several differences from those of the previous workers. The area marks the junction between two tectonic blocks; Khyber block in the north and the Samana block in the south which is separated by Bazar thrust. The Khyber block in the mapped area consists of three major units including Shagai Formation, Khyber Limestone and Landikotal Slate of Pre-Cambrian age, with minor Carboniferous-Permian limestone in the NW part of the mapped area and some undifferentiated ?Jurassic-Cretaceous rocks in the eastern parts of the quadrangle.

The Samana block to the south consists of the Jurassic Samana Suk Formation and the Paleocene Hangu, Lockhart and Patala formations. Meissner et. al. (1973) mapped the same lithologies in the part of the presently studied area in the Samana block except for that they showed the presence of Cretaceous rocks at the southern along the banks of the Mastura River and also extended these lithologies (Cretaceous rocks) northeastwards towards the Bara River. In the present study, no Cretaceous rocks are found along the Mastura valley nor are these found to occupy the Isakai thrust. The Paleocene rocks in the Mastura Valley occupy the footwall of the Isakai thrust and form alternating shallow anticlines and synclines occupied respectively Palaeocene Hangu and Patala formations.

Major results of this study include:

1. The Bazar thrust separates the Precambrian-Paleozoic rocks in the north form the Mesozoic-Cenozoic rocks in the south. The Precambrian-Paleozoic rocks are not found south of this fault in the Samana Block.
2. The Precambrian formations exposed in the northern block in the Bazar-Chora valley of the map have been renamed.
3. The Bara River and the Mastura river valleys are occupied by the Paleocene rocks.
4. The Stratigarphy in southern Samana block has been revised. The Cretaceous rocks are not found in the Mastura River valley and Ukhodarra area and these are mapped as Palaeocene.

Reservoir characterization of upper sand of Lower Goru Formation from core samples of north A-2 well by using geochemical and mineralogical methodology (XRD, SEM and thin section)

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Abstract

From the beginning of oil and gas discoveries petro graphic studies play vital role for development of economy of any industry. The lower Goru Reservoir (sand) has materialized as major hydrocarbon source from the middle and lower Indus platform. This area is demanding due to multifarious mineralogy. Reservoir characterization is very important properties of any Formation. We studied well named North A-2, which is located on latitude 24 34 17 N and longitude 68 36 22 E, on the southern Badin Block of lower Indus Basin Pakistan. The parameters required for this study such as wire line logs, contventional core and well cutting. The analysis of reservoir rock has investigated by core sample of lower Goru Formation from North A-2 well. In Megascopic core analysis, the core sample consist of friable and hard sandstone, fine to medium grained, medium to coarse grain and occasionally coarse grained. A variety of sedimentary structure has been observed. This sandstone mainly deposited in shallow marine environment; its meet the essential criteria of best quality reservoir that is upper shore face crossed sandstones. The remaining part exhibits relatively higher porosity evidence by the study of thin section and SEM. The major diagenetic event that affected porosity of reservoir rock is compaction, cementation, quartz overgrowth and dissolution of rock fragment. Through methodology we have dynamics result of 09 meter long core analysis, the core is courtesy by British Petroleum which is now as United Energy Pakistan.

Detection of forest fires in Margalla Hills Range, Islamabad: A GIS and remote sensing approach

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Abstract

Forests are crucial part of life on earth for maintaining biodiversity and cleaning air to provide indispensable human needs. One can never ignore the importance of forests in daily life. Forest fires can be real ecological disasters, regardless of whether it is caused by natural forces or anthropogenic activities. The primary purpose of this research is to investigate and explore pre and post fire events on Margalla Hills Range to assess forest phenology and vegetation behavior. The research is based on using GIS and remote sensing techniques for detection of burn areas and to correlate the aspects of forest fires with different parameters of meteorological data. Fires at Margalla Hills have become an annual aspect of summer season therefore the present research is to spot out forest fires in Margalla Hills for future detection and control. The material and methods adopted to conduct the study include SPOT-5 Satellite data and GIS approach for identifying and mapping of burn areas using supervised classification methodology. The results indicated that the difference between ground measured and satellite burned area is estimated. The indices results demonstrated that there is decline in vegetation biomass from March to June, 2014. It is concluded from this study that remote sensing is powerful technique for future detection and impact of forest fires.

A study of the gemstones from the Muslim Bagh, Ophiolite Complex, Balochistan, Pakistan

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Abstract

The geology of Muslim-Bagh area, northern Balochistan can be divided into three tectono-stratigraphic zones. At the base is the Calcareous zone consisting mainly of limestone, sandstone and mudstone and is ranging in age from Early Jurassic to Paleocene. This zone is overlain by the suture zone and comprises of the Muslim Bagh Ophiolite and the Bagh Complex. The Muslim Bagh Ophiolite has nearly a complete ophiolite sequence; mantle peridotite at the base transition zone in the middle and the crustal rocks (gabbros, sheeted dykes) at top. The Bagh Complex is an accretionary-wedge complex which comprises of Triassic to Jurassic sedimentary rocks, Cretaceous igneous rocks, pelagic to hemi-pelagic sediments and a small amount of mélange. The Pishin zone (also called Flysch zone) comprises of marine to fluvial successions of Eocene to Pleistocene in age. This study assesses all the three zones in the Muslim Bagh area for the occurrences of gemstones and mineral specimens. For the first time in the history of Muslim Bagh Ophiolite study, the geomological characteristics such as refractive index, specific gravity, inclusions, pleochroism, fluorescence and crystal systems of the collected gemstone are studied using the equipments such as Polariscope, Refrectometre, Chelsea Color Filter, Hardness Tester, Hydrostatic Balance, Spectroscope, Fluorescence, Microscope and Dichroscope. The gemstones and mineral specimens identified and collected from the Muslim Bagh Ophiolite area are natrolite, malachite, azurite, serpentine, and talc from the rocks of ophiolite sequence. Epidote, natrolite, chrysocolla, malachite, azurite, jasper, quartz, green chert, calcite, agate, and amethyst have been reported from the Bagh Complex, while almandine garnet, tsavorite garnet, actinolite, epidote, natrolite, and marble occur in the Metamorphic sole rocks; exposed beneath the ophiolite. Low quality gems such natrolite, jasper, quartz, green-chert, calcite, agate, and amethyst are found within the sedimentary rocks of the area. Field evidences reveal that the gemstones collected from the Muslim Bagh Ophiolite sequence are possibly formed due to the magmatic and secondary hydrothermal replacement processes, while, those from the Bagh Complex are both hydrothermal vein type formed by volcanogenic processes and miscellaneous in origin. Few gemstones such as garnets, marble, quartzite and actinolite are formed by metamorphic processes. Epidote from the north of Muslim Bagh town near Mulghozar village is associated with dykes and may have been formed by rodingitization. The origin of green garnet (tsavorite) found in the basalts of Bagh complex is debatable. The chrysocolla, malachite and azurite are found as stains in the alteration zone of copper sulfides deposits. The gemstones collected from the Pishin and Calcareous zones may be formed by sedimentary processes. Majority of the studied gemstones are semi-precious in nature with few gems such as almandine garnet, tsavorite garnet, natrolite, chrysocolla, malachite, azurite, jasper, quartz, and agate have economic reserves and can be mined for commercial purpose.

Variation of radon in various drinking water sources of Abbottabad, Pakistan

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Abstract

In situ measurements of radon concentrations were taken in all three types of drinking water sources (spring, surface and bore/well) by collecting samples from Abbottabad city and its surroundings. These samples were then analyzed for radon concentrations through active technique, using RAD-7. Doses received through inhalation and ingestion were estimated from these radon concentrations. The radon concentrations varied from 3.6 to 20.6 kBq m^{-3}, 1.7 to 5.4 kBq m^{-3} and 7.0 to 24.0 kBq m^{-3} in spring, surface and bore water respectively with respective mean values of 7.7 ± 4.0 kBq m^{-3}, 2.8 ± 0.90 kBq m^{-3} and 9.4 ± 3.7 kBq m^{-3}. The mean value of radon concentration in all types of drinking water was 6.6±2.9 kBq m^{-3}.This value is less than US EPA Maximum Contamination Level (MCL) of 11.1 kBq m^{-3}. The doses ranged from 0.005 to 0.065 mSv/y with a mean value of 0.018 mSv/y.

Seismic attribute and petrophysical analysis of Dhulian area, Upper Indus Basin, Pakistan by using seismic and well log data

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Abstract

The study deals with Dhulian Area in Northern Potwar deformed zone, Pakistan. Three prominent reflectors namely R1 (Chorgali), R2 (Sakesar) and R3 (Lockhart) were marked on the seismic sections. The marked horizons show deformation in the area caused by compressional tectonics. One thrust fault cuts almost all of dipping seismic lines which was interpreted to be a Fault propagation fold. A time section was produced from the seismic section using the shot points and the two-way-times (TWT) of the reflectors and faults. The TWT was posted on the base map to make a time contour map of the Chorgali, Sakesar and Lockhart Formation as these Formations continue throughout the area, time contour maps showed major contour closures representing an anticline which is bounded by the fault on one side (fault propagation fold). Depth Maps of Chorgali Sakesar and Lockhart formation also represented an anticline with a thrust fault on one side. Seismic time and depth surfaces for three formations verified the time and depth maps representing the fault and the depth /time variations in the formations. Seismic Attribute maps help in identifying reservoir characteristics and give an idea regarding the presence of hydrocarbon. Different Seismic attribute maps including total energy map and instantaneous frequency map along with phase map were created for Chorgali, Lockhart and Sakesar Formation showing considerable variations not only in the centre but also towards north and western side of the area. With the help of these seismic attributes we identified some zones, other then zones of well, towards the north side which were yet to be explored. Well Logs of Dhulian-43 & 39 were used for petrophysical analysis. Petrophysical parameters were calculated including volume of shale, porosity, water resistivity, water saturation and saturation of hydrocarbon. Each well was analyzed formation wise and correlation between the shale volume, porosity, hydrocarbon saturation and water saturation was estimated., In Well Dhulian-39 at depth of 2643-2716meter Lockhart formation showed an increase in oil saturation with an increase in porosity, in the similar well Sakesar formation show some increase hydrocarbon saturation along with porosity at the depth range of 2475-2500meter. In Well Dhulian-43 at depth of 2633-2716meter Lockhart formation showed an increase in oil saturation with an increase in porosity, in the similar well Sakesar formation show some increase hydrocarbon saturation along with porosity at the depth range of 2600-2655meter whereas the latter part is saturated with water. On the basis of these results different zones were identified in Chorgali, Sakesar and Lockhart Formation that were feasible for hydrocarbon presence .these results were later on correlated with attribute maps resulting in identification of new probable zones. The prospective zones in the fault propagated fold of Chorgali, Sakesar and Lockhart Formation in Dhulian area were the primary targets for oil exploration which to greater extent were confirmed in this study.

Late Middle Eocene (bartonian) orthophragminids from Fulra Limestone, Kutch Basin (Western India): regional implications and their correlation to well-known assemblages in Western Tethys (North Africa, Europe and Turkey)

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Abstract

Fulra Limestone is a fossiliferous late Middle Eocene (early Bartonian) shallow-marine unit widely cropping out in Kutch Basin in Gujarat (W India). Owing to its diverse foraminiferal composition, represented by nummulitids, orthophragminids and alveolinids occurring abundantly throughout its stratigraphic range, Fulra limestone serves as a reference-unit for the development of middle Eocene larger benthic foraminifera (LBF) in Indian subcontinent. The coeval fossiliferous units containing orthophragminids and other LBF are exposed to the north of Kutch Basin in Kirthar (Indus Basin) and in Sulaiman foldbelts in Pakistan. The compositions of orthophragminids in these units, however, are not well known. The orthophragminids in Fulra Limestone, previously attributed only to the genera *Discocyclina* and *Asterocyclina*, in fact belong to the evolutionary lineages of *Discocyclina* Gümbel 1870, *Orbitoclypeus* Silvestri 1907 and *Asterocyclina* Gümbel 1870. The genus *Nemkovella* Less, 1987, a common genus in peri-Mediterranean region is not present in the Fulra limestone. We identified two new species of *Asterocyclina* and *Discocyclina*; *Asterocyclina sireli* Özcan et al. 2007 and *Discocyclina kutchensis* n. sp. (Özcan and Saraswati, in prep.). A comparison of Fulra orthophraminids, assigned to shallow benthic zone (SBZ) 17, to the well-described coeval assemblages at northern and southern Tethyan platforms in Italy, Hungary, Turkey, and Tunisia suggests that some species are confined to certain paleogeographic domains. *Orbitoclypeus haynesi*, the only orbitoclypeid and the most abundant orthophragminid in Fulra limestone, appears to be the most common orbitoclypeid in Tunis and some sections in Turkey. In Europe, this species is not known and is replaced by *Orbitoclypeus varians*, the most common orbitoclypeid in middle Eocene of central Europe. Both species occur in varying proportions in marine successions in Turkey. *Asterocyclina sireli*, identified so far only in Turkey, occurs in Fulra limestone and in lower Bartonian deposits in Tunisia. This species is recorded for the first time in Indian subcontinent. Relying on present study, as well as our recent studies in southern Tethyan platforms, we conclude that the generic and specific diversity of orthophragminids dramatically decreases eastward from the peri-Mediterranean region to Indian subcontinent and to the western Pacific region.

Application of remote sensing for geological mapping using landsat ETM+ Satellite image: A case study in Aluli Area, Western Hazara Ranges, North Pakistan

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Abstract

The Aluli area, Western Hazara Ranges, comprises of Precambrian Tanawal Formation, Early Cambrian Abbottabad Formation and Recent alluvium. These formations consist of variety of lithological units including phyllite, quartzites, quartz mica schist, sandstones, siltstones, conglomerates, dolomites, limestones and alluvium. The geological mapping of these constituent lithologies is carried out using Landsat Enhanced Thematic Mapper Plus (ETM+) image enhancement techniques, which include RGB band composition, band rationing and Principal component analysis (PCA). The False Color Composite (FCC) 5-3-1 is found significant to recognize the folds and faults on Landsat ETM+ satellite image. The FCCs 7-5-4, 4-5-7 and 3/1-5/7-5/4 are best in differentiating the geological units. The results are later verified and compared with the aid of field mapping.

Evaluation of source rocks using one dimensional maturity modeling in the Lower Indus Basin, Pakistan

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Abstract

Out of the numerous potential source rocks, present in the Lower Indus Basin, Sembar Formation is the most promising rock unit. The main objective of the study was to find out the lateral and vertical extents and the maturity (thermal) levels of the Sember Formation in different parts of the study area. The study also aimed to infer the timing of oil and gas generation in the region. The study is based on 1D basin modeling (maturity modeling) of twenty two, mainly exploration wells, drilled in the region.

Isopach map of Sembar Formation demonstrates the lateral and vertical extent of the formation; whereas, temperature and Vitrinite Reflectance (R_o) contour maps indicate its maturity levels in different parts of the study area. It is inferred that the thickness of the overlying rock units (overburden) control the maturity level of the Sembar Formation.

It may be noticed that the findings of this study are fully in conformity with the ground realities of the Lower Indus Basin. Discovery patterns and the lateral distribution of various types of hydrocarbons (such as oil, condensate and dry gas) in the region coincides with the modeling results of the study, as can be seen from the burial history diagrams of the twenty two wells. Timing of various types of hydrocarbon generation in the region can be seen in petroleum system diagrams of individual wells. The study shows that Sembar Formation is matured enough to be considered as conventional petroleum source rock or can be exploited as unconventional shale gas source.

Temporal land use change detection using remote sensing and GIS case study of district Lahore and Faisalabad, Punjab, Pakistan

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Abstract

Change in land use is a result of primary and secondary activities of human and nature collectively. To get insight into hidden process related to land cover and land use changes measurement of change detection using temporal imageries can depict quantitative results.

This paper study and compare two heavily populated districts of Punjab that is Lahore and Faisalabad. To carry out the study temporal images of Landsat TM year 1992 and 2009 were used. Supervised classification method is used to measure the temporal change of district growth, in seventeen years. Four main classed were developed i.e. water body, vegetation, open land and build up area. Changes within seventeen years of both districts are extracted and compared with each other to analyze which city have faster growth rate in terms of land use.

To get all the results ArcMap10.x is used to stack, classification, mapping and result finding from the images. Results illustrate Lahore district built-up area was 10.89 % turned to 22.39% of the total area of the district where as Faisalabad district built-up area was 0.98% turned to 3.8% of the total district area within seventeen years. This is due to indigenous population increase and migration from small districts around the both districts, changing land use from agricultural features towards urban agglomeration.

Examination of tectonic activity using RS/GIS approach: A case study of Chaman Fault

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Abstract

This research paper the sensitivity of the hypsometric integral (HI) and its relationship to neotectonics. We used digital elevation models (DEM) 90 m spatial resolution from the Shuttle Radar Topographic Mission (SRTM) to calculate HI values in the Chaman Fault. The Chaman Fault is an active tectonic structure formed as a result of India-Eurasia collision. The goal of this research is to find the tectonics of chaman fault. We used an analysis grid of regular squares of different sizes to calculate maximum, minimum, and mean elevations. The spatial distributions of HI do not show clear spatial patterns and correlation with mean elevation or relief amplitude. We applied spatial pattern analysis using Local Indices of Spatial Autocorrelation (LISA) to measure the degree to which our HI distribution was clustered, dispersed, or randomized. LISA analysis shows that the data are auto correlated because of high positive *z*-scores. Hot spots (clusters with high HI values) are consistent with tectonic uplift and show a strong correlation with the different structural domains in the region. Cold spots represent recent sedimentation close to faults and coincide with shallow earthquake clusters in the region. The HI values do not show any correlation with relative topographic position or lithology. Analysis of HI distribution shows that they are robust and independent of digital elevation model (DEM) resolution but are strongly scale dependent. The LISA technique allows the extraction of clusters of the HI that reveal recent tectonic processes; otherwise it is difficult to interpret the high variability of HI values.

Suitability studies of Kirana Hills aggregate as sub base material at Lahore Ring Road, Northern Phase, Pakistan

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Abstract

The selection of a good quality aggregate plays a fundamental role in road construction projects. Engineering properties of road material implicate a deep impact on aggregate performance. Properly drained and compacted granular sub base material is used between sub-grade and base-course for flexible pavements. Studies were carried out on northern loop (31° 27′ 55″N, 74° 13′ 44″E to 30° 27′ 77″N, 74° 23′ 06″E) of Lahore Ring Road which is a high speed orbital motorway of 85 km length around Lahore city. Various laboratory tests were performed to assess the suitability of Kirana Hills quarried aggregate to be used as sub-base material at the project. Efforts were made to estimate the parameters of strength, durability, particle disintegration, compaction and impact of static load on aggregate. Twenty aggregate samples were subjected to the suitability analysis. Values of Los Angeles Abrasion Test (16%), Soundness Test (7%), Specific Gravity Test (2.82), Water Absorption Test (0.60%), Aggregate Impact Value Test (8%) and California Bearing Ratio Test (70%) indicate that Kirana Hills aggregate can satisfactorily be used as sub-base material for the very project.

Socio-Hydrology of the Indus River Basin: An assessment of changing population dynamics and canal discharge efficiency

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Abstract

Over the last few decades, Pakistan has been dealing with plethora of natural disasters like: floods, droughts, cyclones, earthquakes, and landslides. The incidences and implications of floods in Indus River are experienced by the people located at its periphery and adjoining areas. Risk aversion is an innate ability of human being that enables him to anticipate and assess the risk and discover ways to deal with it. One way of dealing with the risk is migrating from high risk areas towards low risk areas. In contrast to this, the people located on the periphery and adjoining areas of Indus River are adamant on living in high hazard risk areas. Furthermore, it is evident from the population structure of the area that people of low hazard risk areas are also migrating towards these high hazard risk areas that would make them prone to hazards. This study tries to identify factors why people are going from hazard free areas to hazard prone areas in relation to socio-hydrological factors of Indus River. In order to carry out the research, the population dataset of Pakistan is obtained from Landscan 2010 and flood extent vector files of 2010, 2011 and 2012 of Indus River are obtained from UN-OCHA website. Through these datasets, district level population is extracted using ArcGIS Spatial analyst clip analysis tool. And finally, the population in the composite flood extent layer of Indus river is estimated using ArcGIS extraction tool and Microsoft Excel. Afterwards, the NDVI of vegetation around the Indus River and Canals is calculated from SPOT Imagery to identify the migration pattern of people. The results demonstrate that there are certain socio-hydrological factors that have become the reason of this active migration and have forced people to continue living in risk zones. The factors identified can furnish the guidance at government level, thereby; appropriate measures can be taken at government level through the providing the alternate of these identified factors in the hazard risk free areas.

Time series analysis of river discharge rates of major rivers of Pakistan

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Abstract

Remotely Sensed data is the primary source of data to understand natural processes and help us get an insight about possible natural hazards in order to do proactive planning. The purpose of this study is to collect data for discharge rates of major rivers of Pakistan from "dartmouth flood Observatory Website" and to carry out time series analysis on monthly basis. We have created a web application using 'Shiny package' of R programming language; that collects real time data and displays it on two separate graphs. The former shows daily discharge rate of a river for a selected month and later shows monthly averages for any selected year. The web application is simple and quite efficient in collecting necessary data and generating graphs which can be used for visual analysis.

Challenges and opportunities linked with climate change for Pakistan

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Abstract

Warming of the Global Climate System is unequivocal and many of the observed changes are unprecedented over different time scales. The atmosphere and oceans have warmed, the amount of snow and ice have diminished, sea level has risen, and the concentration of Green House Gases has increased. The trigger to the climate system is rising temperature mainly due to the human influence on the natural feedback system. The changes in climate differ in terms of characteristics over time and space. The geographical features of Pakistan make it a unique case for climate change experiences as its northern mountains control the dynamics of Asian Summer Monsoon and they are custodians of world's third largest ice mass after the polar regions. From the south, the Arabian Sea has the potential to produce a number of tropical storms which may become a permanent threat to the livelihood of the vulnerable areas. Increased melting of snow/ice synchronous with the peak monsoon may generate devastating floods in the Indus River System because there is control over the flow of water in monsoon rich area. The temperature increase in UIB during the last century was recorded as 1.1C which was higher than the global average as well as the low elevation plains of the region. In last decade (2001-2010), the increase in the mean daily temperature remained 0.9C above long term average of 1961-90. Pakistan is the major beneficiary and ranks 8th among the most vulnerable countries to the risks of climate change. Basically it is a semi-arid country getting average total annual precipitation about one foot and 60% of its total arable land is irrigated by contiguous network of canals. About 70% is the contribution of seasonal snow and glacier melt to the river flows which have been experiencing extreme inter-annual and inter- as well as intra-seasonal variability resulting into frequent floods and drought. Increasing temperatures have been playing an important role in accentuating the physical processes behind the hydrological cycle resulting into extreme events. Water sector is likely to be the first victim of climate change which may affect agriculture, energy, biodiversity and the socio-economic sectors. Too much water and too less water will be the problematic nexus for Pakistan. Monsoon brings lot of water which could be stored in reservoirs to protect flooding and that water stock can be used for power generation and irrigation of winter crops. Extending summer and shrinking winter in mountainous areas provide an opportunity to grow two crops in a year. The population growth rate in Pakistan is one of the highest in the world which does not allow the match of available resources for sustainable development. Migration of rural population to urban centers may be reduced by establishing small and medium size industry. Climate resilient and highly productive crop varieties along with mechanized farming may satisfy the objectives of food security saving the harvests from pre- and post-harvest losses due to uncertain weather conditions which are likely to prevail under climate change.

Slope stability analysis of Londalen Landslide in Norway by using ordinary method of slices and bishop's modified method

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Abstract

This research was carried out at Natural Hazards and Disaster Recovery, Niigata University Japan. The slope stability analysis was performed to assess the safe and economic design of a human-made or natural slopes (e.g. embankments, road cuts, open-pit mining, excavations, landfills etc.) and the equilibrium conditions. The term slope stability may be defined as the resistance of inclined surface to failure by sliding or collapsing. The main objectives of slope stability analysis are finding endangered areas, investigation of potential failure mechanisms, determination of the slope sensitivity to different triggering mechanisms, designing of optimal slopes with regard to safety, reliability and economics, designing possible remedial measures, e.g. barriers and stabilization. Successful design of the slope requires geological information and site characteristics, e.g. properties of soil/rock mass, slope geometry, groundwater conditions, alternation of materials by faulting, joint or discontinuity systems, movements and tension in joints, earthquake activity etc.

Fellenius (1927) developed this method further, creating a method known as the Ordinary Method of Slices, or Fellenius' Method. Fellenius' Method simplifies the equation by assuming that the forces acting on the sides of each slice cancel each other. Using the same approach, Bishop (1955) refined the method of slices technique by accounting for the interslice normal forces, thus calculating the Factor of Safety with increased accuracy. The method of slices he developed is known as the Ordinary Method slice (Bishop 1955).

Data pertaining to slope stability analysis was manipulated with hand-held calculator. One case was analyzed; it was a real case of Londalen landslide in Norway. First Ordinary Method of slice was calculated in which the slices calculated on the basis of the dimensions slice and unit weights of the soils within them and using the mathematical formula getting final result of londalan landslide is Fs = 0.99
The using the Bishop's modified method the final result of the londalan landslide was different Fs = 1.12

Ultrahigh-pressure eclogites of the Kaghan Valley: Where they come from?

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Abstract

The ultrahigh-pressure eclogites belonging to the Himalayan metamorphic belt, exposed on the Earth surface in the Kaghan Valley of Pakistan, were metamorphosed at pressure-temperature conditions of 2.7-3.2 GPa and 769 ± 50 ºC corresponding to mantle depth (>90 km). The pressure-temperature estimates were made using conventional geothermobarometers on the peak eclogite facies minerals (e.g., garnet, omphacitic clinopyroxene, phengite and coesite). The presence of coesite inclusions in omphacite in these rocks also confirms their depth of formation at mantle depth. Since, eclogites are mafic rocks, they usually form from the transformation of basaltic or gabbroic protoliths when subducted to considerable depth (eclogite facies stability field). The protoliths of the Himalayan eclogites were derived from an extensive volcanism along the northern margin of India when it was part of the Gondwana supercontinent. Based on the U-Pb zircon age-dating, the Panjal Trap basaltic volcanism occurred in Permian (ca. 267 Ma). After the break-up of India from Africa, Antarctica and Australia, the Indian continent moved northward and collided with Asia in the Eocene (ca. 50 Ma from the U-Pb zircon age-dating) near equatorial regions. Due to this continent-continent collision the Panjal Trap basalts, part of the subducting Indian lithosphere, underwent ultrahigh-pressure eclogite facies metamorphism at depth greater than 90 km (coesite stability field). In this paper, we will present a review on the evolution of the basaltic volcanism, the paleoclimate during that time when the volcanic activity was going on along the Indian margin, the northward drift of Indian plate, and the subduction-related ultrahigh-pressure metamorphism. Our petrological, geochemical, and geochronological results provide sufficient evidence how the Kaghan Valley eclogites formed, what were their source magma, how the metamorphic processes affected these rocks geochemically during their subduction to mantle-depth, and up to what extent these rocks retrograded during their exhumation to the earth's surface?

Integrated study of microfacies, XRD supported by SEM, wire line logs of Jutana Dolomite at Khewra Gorge, Salt Range Punjab, Pakistan

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Abstract

The current investigation related to integrate the microfacies, XRD data complimented with SEM along with wireline logs of Jutana Dolomite of middle-late Cambrian age in Khewra Gorge in Eastern Salt Range is carried out. The deposition of Jutana Dolomite is primary on carbonate plate form in peritidal environments, ranging from supratidal to subtidal; however, later on the digenesis has obliterated most of its primary feature, and thus makes its primary origin doubtful. This can be understood by classifying the microfacies into four types as (a) Siliciclastic Algal laminated Dolomite Breccia (MJD-1), (b) Burrowed Sandy Ferroan Dolomicrite (MJD-2), (c) In-situ Medium-Coarse grained Dolomicrite-Dolosparite (MJD-3), (d) Fine grained Micaceous Crackled Sandy Dolosparite (MJD-4). This study is further supported by XRD analysis, which suggests that the Jutana Dolomite is nearly stoichiometric and less ordered, such kind of the dolomite are interpreted as early diagenetic. This is supported by the presence of anhydrite under SEM. The data obtained from wireline logging is in close comparison with previous data. In this case four facies were introduced by interpreting the cross plot data obtained from neutron porosity log and total formation value. The environment for Jutana Dolomite is interpreted by cross plot graph and it ranges from subtidal to intertidal.

Seismic clusters in and around Pakistan

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Abstract

A proper understanding of seismic hazard zonation plays a vital role in seismic hazard analysis. The current work presents delineation of seismic clusters in and around Pakistan (23°N-39°N; 60°E-80°E) based on homogenized earthquake catalogue. A new, magnitude-homogenous earthquake catalogue is developed for Pakistan and the surrounding area, covering the period 734 A.D. – 2007 A.D. The method of maximum curvature is implemented for assessment of the completeness magnitude Mc and its standard deviation δMc. The post-1900 data is used for delineation of seismic clusters in and around Pakistan using K-means cluster analysis. K-means cluster analysis is used to generate a new, objective seismic source model for Pakistan. The K-means cluster analysis leads to different seismicity cluster partitions for Pakistan using clusters quality index methods and stochastic hazard analysis in the form of Monte Carlo simulation. Partitions of the seismicity containing 9 to 19 earthquake clusters emerge as the most appropriate modelling seismicity in Pakistan, with the 19-cluster K-means model integrated into the ensuing Monte Carlo seismic hazard analysis. The 19-cluster K-means model has been selected to characterize the seismicity of Pakistan and the surrounding region (Afghanistan, Tajikistan and India).

Magnitude recurrence hazard in and around Pakistan

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Abstract

The seismotectonic framework of Pakistan has been produced by interaction between the Eurasian, Indian and Arabian plates. Pakistan and its neighboring countries have experienced many large earthquakes throughout recorded history, often resulting in considerable damage and loss of life. A magnitude-complete data set of earthquakes located in and around Pakistan is used to perform a region-wide analysis of seismicity and earthquake hazard in Pakistan, using Gumbel's third (G^{III}) asymptotic distribution of extreme values. Results estimate expected extreme magnitudes in and around Pakistan using the G^{III} distribution for return periods of 50 years, 100 years, 200 years and also with 10% probability of exceedance in 50 years, equivalent to an earthquake with a 475-year return period. Earthquake hazard results are presented as contoured maps. These maps exhibit higher magnitude hazard in Makran, Quetta and Kutch in the south of the considered region, and Hindukush, Karakoram, North-west Himalayan fold and thrust belts in the North. It is clear in these maps that higher magnitude hazard is adjacent to known seismogenic features and faults: for example, the Chaman Fault, Makran Coastal Fault and Kutch Fault in the south and Main Karakoram Thrust, Main Mantle Thrust and Main Boundary Thrust in the North.

Structural evaluation and mapping of Dandot Area, Kallar Kahar, Punjab, Pakistan

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Abstract

This project is aimed at detailed structural investigation of a part of Central Salt Range, east of Kalar Kahar. The study area is thoroughly influenced by activity along the Salt Range Thrust. The major trend of the hinges of the ridges is northeast-southwest in the south to almost east-west in the northern section of the area indicating strong northwest-southeast to north-south compressive stresses. The salt range thrust terminates in subsurface with tip line buried under the hanging wall ramp of the anticline or under the recent deposit of Punjab plain. Local thrust faults are present in the area which are believed to be emanated as a splay faults from the salt range thrust. The normal faults are evolved in response to collapse of competent strata over riding critically above the weak strata. The restored section shows that the area is accommodating 72km of slip which accounts for 38% of shortening.

Another Drought? Are we prepared?

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Abstract

In May 1997 the term El Niño suddenly became pandemic and spread across the globe like a jungle fire. This was due to the horrific effects that were brought down on the humanity and their planet earth by the most potent climatic phenomenon of the 20th century.

El Niño develops in response to weak easterly trade winds over the eastern Pacific Ocean forcing warm western Pacific waters to swell and heat up the central and eastern Pacific. La Niña typically follows El Niño, and causes the western Pacific waters to warm up and cooler central and eastern Pacific waters. Together these two phenomena cause weather changes on global scale, particularly in tropical Pacific.

The 1997-98 El Niño brought severe drought in southern Pakistan and the La Niña conditions caused the worst flooding in the history of Pakistan in July-August of 2010.

This year in late February, a bulge in the equatorial Pacific waters off the coast of northeast Australia was noted—a sign of the start of Kelvin wave or simply the beginning of an El Niño. The Kelvin wave has now spread eastward to the central Pacific waters and is heading towards the eastern Pacific. Although, it is not yet certain if the El Niño will develop to its fullest, but if it does then we must be prepared. The definitive confirmation of full development of the El Nino will only be clear by the end of 2014. The fuller extent of El Niño will bring, similar to 1997-98 or even worst, drought conditions in southern Pakistan. The preparation can include contingency planning, rainfall monitoring, water conservation strategies, relocation strategies, water storages, emergency health facilities, live-stock preservation strategies, selection of right crops in the foreseeable drought hit areas of southern Pakistan and federal/provincial government coordination.

Application of geospatial technology in determination of neotectonics of Chitral Valley, Hindu Kush Area, Northern Pakistan

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Abstract

Chitral valley Hindu Kush range, northern Pakistan, situated over the NW corner of collision region of Indian and Eurasian plate. It is one of the most tectonically active regions because of the abduction processes of Eurasian plate. Intermediate depth earth quakes are routine practice here. Mapping of Neotectonics is an issue of concern now a day. Neotectonics assist us in assessing of seismic hazards and to understand the nature of deformation of the region. The main purpose of this research is to detect the active and neo tectonics of Chitral Valley. For this purpose, 90 m SRTM DEM is used for automated stream generation. Geomorphic indices of steam profile analysis are analyzed in Mat lab over the stream network of study area, steepness and concavity maps are the final output. These maps are quite helpful for the analysis of active tectonics as erosion and uplift of the study area is computed. Further drainage density is calculated in order to verify the former results. All the minor and major streams were analysed. With the help of these geomorphic indices it is proposed that Drainage network of study area is totally tectonic induced and deformed because of active tectonics. Areas of active deformation along the major faults are also marked.

Multi-scale mapping of supra-glacial lakes and their associated glaciers for assessment of lake outburst flood hazards under changing climate in Hunza Karakoram-Pakistan using remote sensing and GIS tools

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Abstract

The glaciers of Hunza River Basin in the Karakoram Range of Pakistan have been declared as rapidly retreating at significant rates during the recent decade under changing climatic conditions. Particularly high ablation rates for the snout of Batura Glacier in upper Hunza are recorded as annual ablation on bare ice of 1841 mm per year during an ablation season of 315 days. As a global consensus, it has been declared that glaciers from all over the world are dramatically retreating and are expected to continue as the globe is getting warm drastically over the coming years. While the significant changes in glacier dynamics and the rapid formation of pro-glacial lakes under changing climate is challenging in high mountain regions around the world. In combination, rapid growth and development of glacial lakes and retreating glaciers are provoking serious hazards in the high mountain cryospheric environment.Global warming and extreme weather events may initiate potential mass movements in terms of landslides, debris-flows, rock/ice avalanches or mudflows which can act as potential triggering factors for the lake outburst floods.

The present study is based on three research levels in order to study the Glacial Lake Outburst Flood (GLOF) Hazards in detail and to develop a correlation between Lake Outburst Floods with changing climatic conditions in Hunza River Basin. Level-1 includes mapping of spatio-temporal variations in supra-glacial lakes over selected Hispar and Batura glaciers, which are located in Hunza River Basin, Karakoram Range of Pakistan and are losing their ice mass rapidly under conflicting climate peculiarities in this topographically complex region. Glacial lakes were mapped using satellite images of LANDSAT-7 (ETM+) and LANDSAT-8 based on spectral classification of digital images in ArcGIS.Critical lakes were identified and modelled for GLOF hazard assessment based on their peak flow discharge and geomorphological conditions. Level-2 of this research is the evaluation of rate of drifting of Hispar glacier and it's Accumulation Area Ratio (AAR) in terms of glacier mass balance. Level-3 includes mapping of maximum snow extent of Hunza Basin and assessment of snow-cover dynamics during the last decade (2001-2011) in a GIS-based environment to observe the snowline shift under different climate scenarios and the resulting fluctuations in discharge of Hunza River.

Depositional modeling of the Bathonian-Callovian carbonate unit in Hazara Basin, Pakistan

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Abstract

The current work presents a detailed study of the middle Jurassic Samana Suk Formation in the Hazara area. This carbonate dominated formation was deposited on the northern shelf of the Tethys Ocean. The study is based on four exposed stratigraphic sections to envisage its outcrop features, microfacies analysis and diagenetic imprints. The outcrop features are characterized by cross bedding, ripple marks, mud cracked horizons, tempestites, burrow mottling and bioturbation. The depositional environments for respective sections were intergrated into a single depositional model and it has been suggested that deposition of the Samana Suk Formation took place on a gently dipping ramp platform. The marginal marine settings of this platform were occupied by inner ramp peloidal, bioclastic, ooidal beaches and shoals. Lagoons, its beaches and tidal flats were also dominant in some places. The fine grained skeletal limestones represent middle ramp settings whereas the planktonic mudstones show evidences of marine transgressions. A variety of allochemical constituents are present in the formation including skeletal and non skeletal grains such as ooids, peloids and intraclasts. The processes of biogenic alteration, compaction (including pressure solution), neomorphism, dissolution, dolomitization, cementation and fracturing are clear manifestation of the diagenetic processes that occurred in the formation.

Petrophysical analysis of the reservoir intervals in Kahi-01, Kohat Sub-Basin Basin, Pakistan

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Abstract

This study deals with the petrophysical analysis of the Kahi-01 in Kahi Village within Kohat Sub-Basin (Upper Indus Basin) for evaluating the reservoir potential of identified intervals. This was achieved by using different parameters. Three formations namely, Lockhart Limestone, Hangu Formatin and Lumshiwal Formation were selected for further investigation according to the cut off factor. The Lockhart Limestone with dominant lithology of limestone having 36m thickness, with the vuggy and crystalline type of porosities is considered to be hydrocarbon wet and water dry. The Hangu Formatin has thickness of 50m with dominant lithology of sandstone. The analysis shows that the grain size has a range of silt to fine sand. There were three prospective zones identified as A1, A2, and A3 with high hydrocarbon saturation and less shale content having the thickness of 7m, 15m and 22m respectively, in which A3 zone is more promising than the rest. The Lumshiwal Formation has a thickness of 75m, with dominant lithology of coarse sandstone. The prospects as compared to the intervals identified within Lockhart Limestone and Hangu Formation are not much promising, however, with fair amount of hydrocarbon saturation and coarseness of the grain size of the sandstone suggests it to be a significant reservoir.

Remote sensing based lithological/stratigraphic mapping and mineral exploration in Salt Range, Pakistan

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Abstract

The southern border of hydrocarbon-bearing Potwar Basin is known as the Salt Range Thrust (SRT). The Salt- and Trans-Indus ranges have got wealth of mineral potential and mining has been going on for ages. Coal mines, salt, gypsum, limestone, fireclay, silica sands, uranium and fossil fuel are very economic occurrences among others. The Salt Range has a unique lithology, stratigraphy and wealth of minerals deposits; however, due to its large spatial extent, rough terrain and remote location, most of it has remained under-unexplored. The current advancement in the satellite based remote sensing and geospatial techniques and its uses in the remote areas, especially rough terrain and at regional scale have shown that these techniques have proved very successful in unraveling the geology and mineral resources. Satellite remote sensing images are frequently and efficiently used for mapping different minerals of economic importance and rock units with varying lithology and stratigraphy. The aim of this study is to use these innovative technologies of SRS and GIS and state-of-the-art techniques to map lithological/stratigraphic units and detect mineralized zones.

The Advanced Spaceborne Thermal Emission and Reflection Radiometer (ASTER) satellite sensor launched by NASA-USA presents unprecedented opportunities for lithological mapping and mineral exploration. We used the Short Wavelength Infrared (SWIR) bands of ASTER images to map lithological/stratigraphic and mineralized zones in salt range. The spectral reflectance of known minerals, stratigraphic/lithological units are used to classify the ASTER images using Principal Component Analysis, Spectral Angle Mapper, Decorrelation Stretching and Band Rationing to discover the unknown minerals and produce seamless and more detailed lithological, stratigraphic map for the region. The remote sensing derived Digital Elevation Model (DEM) providing the topographic information of the region and DEM derived drainage network were used in integration with ASTER images to classify the lithological and stratigraphic units. The mapped mineralized zones using remote sensing can attract the government and private sector for further investigation for minerals exploration and might lead to the discovery of minerals deposits. Similarly the seamless and more detailed information on lithology/stratigraphy and of the region shall assist the hydrocarbon industry in the country and abroad to explore and understand the tectonics and petroleum system in the region.

Role of emerging technologies in disaster management

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Abstract

Disaster Management is a holistic approach to develop broad based policies, processes and procedures, which can improve the preparedness and mitigation capacity of the communities in case of any unfavorable event. Pakistan, due to its geo-political location has been exposed to many manmade and natural disasters. In a period of only five years (2005-10), Pakistan has experienced the worst earthquake and torrential floods. The emerging technologies like remote sensing, GIS, mobile and cellular technologies on the other hand, has been effectively mitigated the impact of such disasters through better planning and more informed decision making. In this paper the application of various technologies for disaster preparedness and mitigation has been discussed. A case study of vulnerability assessment of built environment with the help of satellite imagery and remote sensing has also been given. It is expected that with more application of emerging and latest ICT and Satellite based technologies, the disaster preparedness and mitigation can also be improved at Pakistan.

Evaluation and performance improvements in the construction techniques of mud houses in flood affected areas of Swat

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Abstract

About one third of people from all cultures and in climates live in earth constructed houses. From the roof of the world in Tibet, or the Andes Mountains in Peru, to the Nile's shore in Egypt, the deserts of Middle East or the fertile valleys of China, earth is used as one of the major construction material.

Flooding, due to flash and riverine floods, snowmelt floods, is the most taxing of water-related natural hazards to humans, material assets, as well as to cultural and ecological resources. Annually, flooding affects about 520 million people and their livelihoods, claiming about 25,000 lives worldwide. The annual cost of flood damages to the world economy is between $50 and $60 billion. The devastating floods brought about by Oct 2010 monsoon rains resulted in a disaster that was unprecedented in Pakistan. The flood affected 20% of the country, rendering almost 20 million people homeless, with around 2000 dead.

In this study flood performance of the mud houses in Swat valley has been analyzed on the basis of field observations. Furthermore design and construction improvements have been suggested for better performance of mud houses in floods. It has been observed that the performance of mud houses can be improved with very little additional cost, which can save the precious lives and property in the wake of natural disasters.

Paleoenvironmental analysis of the Early Permian Dandot Formation, Salt Range, Punjab, Pakistan

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Abstract

The Late Carboniferous-Early Permian marks a significant Pan-Gondwanan global eustatic sea level rise as a result of deglaciation recorded in many Gondwanan continents. The deposition of Dandot Formation, Salt Range represents the manifestation of this sea level rise in Pakistan. This study focuses on the sedimentological and paleoenvironmental analysis of the Dandot Formation to investigate the development of this unit in the background of declining Gondwana Carboniferous-Permian glaciations. Five stratigraphic sections were selected and studied in eastern, central and western Salt Range to understand the distribution, lithofacies types and facies associations. Seven lithofacies have been identified which are grouped into two facies associations; 1. Shoreface to offshore facies association, and 2. Tidal flat and estuarine facies association. The Dandot Formation thus represents deposition in shallow marine to tidally influenced environment with part in eastern Salt Range representing relatively deeper environments as compared to the central Salt Range. The deposition of the glacially induced underlying Tobra Formation and fluvial deposited overlying Warchha Formation suggests that the Dandot Formation shows the initiation of the deglaciation in Pakistan as a result of declining Gondwanan glaciation in the Carboniferous-Permian time, however further work involving the playnostratographic correlation of the unit with the deglacially deposited units in the palaeogeographically nearby regions like Middle East and India will give good confidence to establish these findings.

Partitioning of deformation across the metamorphic hinterland in the Swat Region, Pakistan Himalayas

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Abstract

A prograde metamorphic mineral assemblage characteristically evolves with porphyroblast growth when a succession of pellitic rocks follow pressure and temperature (P-T) trajectories during Barrovian metamorphism. Since the advent of the concept of metamorphic facies, extensive research has been done on porphyroblasts composition and their key role in thermodynamic modelling of P-T paths. An outstanding result of these studies is the recognition of typical high T vs. high P metamorphic belts across the globe, reflecting a significant role of porphyroblasts in our understanding of mountain building processes. It has been envisaged that the deformation partitioning controls porphyroblast growth in ductile environment and prohibits porphyroblast rotation – a hypothesis that sparked a lively debate in early 1990's and continues undecided today. In this study, it has been demonstrated that how deformation partitioning controls porphyroblast growth during regional metamorphism without significant rotation. The mechanism operates at different scales and provides a window to compare tectonic processes from porphyroblast to the whole orogen. 61 oriented rock samples were collected from the Swat region, which represents the metamorphic hinterland of the NW Himalaya. Advanced 3D micro-structural techniques have been used to unfold deformation partitioning phenomena.

3D geometry of inclusion trails preserved within porphyroblasts was studied in each sample using two independent techniques, namely the 'asymmetry switch' of curved inclusion trails and the 'FitPitch' software analysis. Both methods revealed remarkably consistent orientation of intersection or inflection axes preserved in porphyroblasts. These geographically "fixed" axes, also known as the foliation intersection axes (or FIAs) grouped into three orientation classes, obtained coherently with relative time constraints from many samples: 1) ESE-WNW 2) E-W and 3) NNE-SSW directions corresponding to three different shortening directions during progressive deformation of the Himalayan orogen. Each FIA set is preserved by unique class of porphyroblasts that grew during subsequent deformation event. Different stages of porphyroblasts growth with their respective FIAs, despite having been hosted by samples collected from different locations and even rock formations, revealed remarkably consistent orientations across the region. This is because of the shifting patterns of deformation partitioning operated at porphyroblast scale where the progressive bulk inhomogeneous shortening dominate over other mechanisms at the orogen scale.

Reserve estimation techniques in unconventional resources and comparison of different available methods

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Abstract

An energy crisis is looming large in upcoming years. The major shortfall is expected in natural gas supplies. Pakistan has 28 trillion cubic feet reserves (TCF) of conventional gas but due to increase in its demand it is expected to depleted in next two decades. With the widening demand/supply gap we have to rely on the unconventional resources. So it is the need of the hour to develop them. According to Energy Information Agency (EIA) estimates, Pakistan has approximately 40 (TCF) of tight gas and 51 TCF of shale reserves and ranked 8th in the world in shale reserves. Unlocking these large unconventional reserves can expands the opportunity to reduce Pakistan's dependence on imports to overcome the current energy crisis and to fuel the industrial economy.

But to develop these resources is not as easy as conventional resources. There are a lot of challenges faced by industry in exploitation of these unconventional resources, starting from exploration, reserve estimation, drilling, and reservoir development. This paper will analyze the different methods used for reserve estimation in unconventional plays. Reserve estimation is an important factor in deciding whether to go for development or not. Unrealistic estimates can lead us to economic loss. The most common methods used to determine reserves are volumetric, flowing materials balance, decline curves analysis, and reservoir models. Assessment of strength and weakness of individual reserve estimation techniques will be presented in this paper and after doing the comparison of all these available methods an attempt is made to suggest the best method for reserve estimation in unconventional reservoirs at different stages of development.

Sedimentology and diagenesis of Samana Suk Limestone and Sirban Formation exposed along Khote Di Qabar to Abbottabad road section, district Abbottabad, Khyber Pakhtunkhwa, Pakistan

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Abstract

The Sirban Hills represents the foot hills of the Himalayas trending in the north eastern direction. The Cambrian Sirban Formation of the Abbottabad Group and Jurassic Samana Suk Limestone are exposed along the Main Karakoram Highway from Khote-Di-Qabar upto Sirban Hills, Abbottabad, Southern Hazara. As a part of this research, samples were collected from the successions. Petrography and XRD analysis of the collected samples were carried and various facies, diagenetic fabric and depositional environments of the two lithologies were interpreted.

The Samana Suk Limestone composed of limestone, dolomitic limestone and chert is interpreted to have been deposited in shallow carbonate near shore inner shelf environment that records a set of post-depositional, diagenetic alteration marked by changes in fabric elements like micritization, neomorphism, dolomitization (non pervasive), selective silicification, pressure dissolution and formation of microstylolites resulting in the development of stylo-nodular fabric, tectonically-induced fracturing and generation of coarse spar. The Sirban Formation mainly comprised of dolomite, dolomitic limestone, chert, sandstone is interpreted to have been deposited in an evaporitic environment and records various stages of syn-depositional and post depositional changes resulting in the alteration of fabric, i.e., micritization, neomorphism, dolomitization (pervasive and non pervasive), pressure dissoluion and insitu brecciation.

Petro-chemical investigations of the rocks of Golo Das and surrounding areas Gilgit-Baltistan, Pakistan in the perspective of gold and base metals mineralization

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Abstract

The study area which includes Golo Das and surrounding areas is a part of Ghizar District of Gilgit-Baltistan province. Geologically, it is located just south of the northern suture zone (NSZ), a mega thrust separating the rocks of Karakoram plate from the Kohistan island arc. The rocks exposed in the study area are mainly basalt-andesite sheet dominant (BASD) volcanics and Ishkoman volcanic centre (IVC) volcanics of Ghizar formation intruded by stage-2 diorites of Kohistan batholith. Petrographic study shows that the BASD volcanic are highly deformed while the IVC volcanic are undeformed. Diorites of the study area are fresh looking and consist of two varieties one having majorly plagioclase, hornblende and biotite, while in the second variety plagioclase, biotite and augites are present in abundance. On the basis of whole rock geochemistry, the studied BASD volcanics are basaltic in composition while the IVC volcanics are classified as basalt-andesites. The spider diagrams of both BASD and IVC volcanics as well as diorites indicate enrichment in large ion lithophile elments (LILE) relative to high field strength element (HFSE) with well-defined negative Nb and positive Sr anomalies.The sulfide-bearing altered / sheared zones present within IVC volcanics are studied for chemical concentration of gold and silver and other base metals like Cu, Pb, Zn, Ni, Cr, Co, and Cd. The enrichment of Au, Ag, Cu and Co is noticed in these zones which could be attributed to the alteration caused by the hydrothermal fluid. Major and trace elements data of the studied Ghizar Formation (i.e., BASD and IVC volcanics) and diorites are plotted on the discrimination diagrams. The data suggest that these rocks are akin to the fields defined for subduction related calc-alkaline rocks of island arc type of setting. On the basis of chemical characteristics, the rocks of the Ghizar Formation, especially the IVC volcanics, are considered as the eastern extension of the Teru Volcanic Formation/Shamran volcanics.

New standards for conduct and reporting of mineral exploration projects

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Abstract

Over the last couple of decades advanced mining economies have developed new standards for conduct of mineral exploration and reporting of results in order to keep pace with the changing requirements of mineral businesses in an increasingly globalized world. The aim of the new standards is four fold: a) to ensure that exploration is conducted by professionals with education and experience relevant to the mineralization being investigated (Qualified Person - QP concept), b) to ensure that the QP conducts the exploration in accordance with internationally accepted 'best practices guidelines', c) to stipulate that the QP verifies all data/information and reports the exploration results in a standard format, while stating the mineral resources and reserves in terminology that is clearly understood globally, and d) to require the QP to ensure a high standard of professional work and be personally accountable for factual errors and omissions in his work. Taking the Canadian standards as an example, this paper presents and explains the new standards.

The new standards empower geology and mining engineering degree holders to be given leading roles in mineral exploration and exploitation. In fact major mining jurisdictions make it mandatory that a QP's report is written and issued on a mineral prospect before investment capital is solicited on a stock exchange. A QP's report is recommended even for soliciting private equity participation. However this power comes with responsibility of protecting the investing public at pains of disciplinary action against the QP for unprofessional and unethical conduct.

Initially each major mining country developed its own standard. Lately there is an international effort on-going to develop common standards such that 'one standard will apply to all'. An international 'Committee for Mineral Reserves International Reporting Standards' (CRIRSCO) issued the first 'International Reporting Template' in November 2013. This template is also discussed in this paper.

This paper is a call for action for the Economic Geoscientist and Mining Engineering community of Pakistan to organize themselves and work to the new standards. If we wish our mineral business to grow, in this increasingly globalized world economy, we must make the effort to understand and apply the new standards and adhere to the standards from planning to the ultimate reporting of our mineral exploration/exploitation activities.

Facies and structural analysis of the Janakor Valley, FR Peshawar, NW Pakistan

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Abstract

The sedimentary succession of the Janakor valley, which is located 35 km in south-eastern vicinity of Peshawar city, is investigated for the lithofacies, microfacies, biostratigraphy and structural analysis. Based on litho-biostratigraphy and order of superposition, the rock units exposed in the area ranges in age from Mesozoic to Miocene, namely; Samana Suk, Lumshiwal, Kawagarh, Hangu, Lockhart, Patala and Muree formations.

The microfacies investigations of the Samana Suk Formation revealed Ooidal-Peloidal Grainstone (SKJ-MF-1), Micritized Ooidal Grainstone (SKJ-MF-2), Echinoidal Bioclastic-Peloidal Grainstone (SKJ-MF-3), Ooidal-Peloidal-Packstone (SKJ-MF-4), Bioclastic-Peloidal Packstone (SKJ-MF-5), Sandy-Peloidal-Packstone (SKJ-MF-6), Spicules rich Mudstone (SKJ-MF-7), Bioclastic-Intraclastic Mudstone (SKJ-MF-8) and Dolostone (SKJ- MF-9) microfacies. The microfacies assemblages of the Samana Suk Formation indicate inner ramp shoals to outer ramp settings for its deposition.

Based on the outcrop and petrographic investigations, the Lumshiwal Formation is divided into two sedimentary facies i.e. Sandstone lithofacies A (LMJ-LF-A) and Sandstone lithofacies B (LMJ-LF-B). These lithofacies suggested that this rock unit is deposited in fluvio-deltaic settings.

Three microfacies namely; Planktonic Foraminiferal Packstone (KGJ-MF-I), Intra- Bioclastic Mudstone (KGJ-MF-2) and Planktonic Foraminiferal Mudstone (KGJ-MF-3) are reported for the Kawagarh Formation. The microfacies assemblages of the Kawagarh Formation suggest open marine pelagic environment for its deposition.

The Hangu Formation in the Janakor valley consists of Sandstone lithofacies-A (HJ-LF-A) Laterite (HJ-LF-L), Sandstone lithofacies-B (HJ-LF-B), Sandstone lithofacies-C (HJ-LF-C), Carbonaceous Shale (HJ-LF-CS), Coal (HJ-LF-CL), while two microfacies i.e. Algal Laminated Mud-stone (HJ-MF-1) and dolomitized Lime mud-wackestone (HJ-MF-1) microfacies are also reported. Based on the lithofacies and microfacies the Hangu Formation, fluvio-deltaic to tidal flat marshy settings are interpreted for its deposition.

The Lockhart Formation is consisted of *Miscellanea* wakes-Packstone (LJ-MF-1), *Miscellanea Algal* wakes-packstone(LJ-MF-2), *Milliolid-Algal*-Bioclastic Wake-Packstone(LJ-MF-3), Bioclastic-*Dasycladale*-Wackestone(LJ-MF-4), *Algal-Lockhartia*-wackestone(LJ-MF-5), Planktonic Foraminiferal-*Orbitoclypues* Wackestone(LJ-MF-6), Bioclastic-Wackestone(LJ-MF-7), Bioclastic-Reworked-Larger Benthic Foraminifer-Mudstone(LJ-MF-8), Smaller Benthic-Planktonic Foraminiferal-Mud-stone(LJ-MF-9), Planktonic Foraminiferal-Mudstone microfacies (LJ-MF-10). The microfacies assemblages of the Lockhart Limestone suggest that it is deposited in the inner restricted to outer ramp settings.

Based on the outcrop data and petrographic studies the Patala Formation is composed of Carbonaceous Shale Lithofacies (PJ-LF-Cs), Green Shale Lithofacies (PJ-LF-Gs), Planktonic Foraminiferal Mudstone Microfacies (PJ-MF-1), Larger Benthic-Foraminiferal Mud-Wackestone (PJ-MF-2), and Siliciclastic Mudstone Microfacies (PJ-MF-3) microfacies. All the lithofacies and microfacies of the Patala Formation indicate that this formation is deposited in the middle to outer ramp settings.

The structural investigation of the area suggests that the area of investigation is located in the hanging wall of the Main Boundary Thrust (MBT). All the folds are overturned in the direction of NNE and are trending in EW direction. All the thrust faults are back thrusts and show propagation in NNE direction. The overall EW trends of the structures suggest a NS compression. A relative younger phase of EW shortening is also observed in the study area. This younger phase of deformation may represent the EW shortening associated with the deformation along the Chaman Transform Faults.

Integrated sequence stratigraphic framework of the Mesozoic to Miocene sediments, Janakor Valley FR Peshawar, NW Pakistan

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Abstract

The Janakor valley is located 35 km from the Peshawar city in its south-eastern vicinity. The sedimentary succession of this area ranges in age from Mesozoic to Miocene. The outcrop, biostratigraphy and microfacies details of the sedimentary rocks of the area are integrated for establishing a reliable sequence stratigraphic framework for the said strata. Such an integrated approach revealed that the Samana Suk Formation is deposited in High Stand System Tract 1 (HST1), while the Lumshiwal Formation is deposited in Low Stand System Tract 1 (LST1). The transgression of sea is recorded in the pelagic sediments of the Kawagarh Formation, which is deposited in Transgressive System Tract 1 (TST1), while the lower part of the Hangu Formation is deposited in the LST 2 and its upper part is record the onset of TST2. This transgression continues and its final imprints are recorded in the Lockhart Formation and lower part of Patala Formation. The upper part of the Patala Formation record progrdation, hence the stat of HST2 which finally ended up in the early closure of the Tethys oceans, which subsequently resulted in the onset of the molasse sediments of the Muree Formation.

Safety, earthquakes and Pakistan's electrical power system

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Abstract

The electrical power sector encompasses distribution companies, the transmission companies and generation companies. All these entities are required to adopt or adapt the safety standards and norms for installation, operation and maintenance. The workforce of these entities particularly the live-line crew and linemen are at more risk. In Pakistan sometimes safety codes of foreign countries are used with or without adjustments to local conditions i.e. chemistry of atmosphere, geological, geographical hazards etc. (These safety manuals of different electric companies may not necessarily meet the indigenous requirements of our country and lack uniform basis with no legal status, therefore various accidents in the past were seen). Moreover, no comprehensive study has been done in Pakistan on seismic performance of electrical system and requires immediate attention as Pakistan is one of the highly seismic active region in the world with potential of large earthquakes. This paper will describe the minimum requirements for safeguarding electrical power systems against strong ground motions, proposing seismic qualification criteria for electrical equipment, to establish the resilience of electrical power system and quantification of functionality in regard to seismic resilience which is a new dimension in electrical power system engineering worldwide.

Estimating cyclone's sites of intensifications and patterns using sea-surface temperatures in coastal areas of Pakistan and surroundings

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Abstract

Along with many other factors, the Sea Surface Temperature (SST) is a critical deciding component of Tropical Storms creation and their propagation path. Using historical SST and cyclones data it is possible to predict the conditions and estimate the paths and sites of intensification of tropical cyclones in future. Taking into account NOAA's historical daily averages of SST and global historical cyclones shape files data from 1998 to 2013, cyclones along Pakistan and Indian coastal area are mapped with their speed during every 6 hours duration. By comparing and analyzing the parameters during the cyclone and pre cyclone time, we tried to extract a pattern of cyclone occurring conditions and intensification sites. Results can be efficiently applied to predict the cyclones, their sites of intensifications and generate a timely warning in the most likely to be hit regions.

Microfacies and reservoir characteristics of Kirthar Formation, district Jamshoro, Sindh, Pakistan

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Abstract

Microfacies and Reservoir Characteristics of Kirthar Formation exposed in Jamshoro district is undertaken to better understand its depositional environment, age and to correlate the other units/members of Kirthar Formation present in sub surface of Indus Basin. The lower contact is confirmed with Tiyon formation whereas its upper contact is unconformable with Nari Formation. The limestone of Kirthar Formation is highly fractured and bears 5-10 cm. displacement in between individual blocks. The joint are of rectangular shape and shows systematic pattern. The space between joints ranges from 5-16 cm. The tevertrine limestone with stalagmite and fractured blocks shows room for accumulation of hydrocarbon. 10 microfacies have been identified and compared with SMF type shows different faunal assemblages and depositional environments. The faunal assemblage of Kirthar Formation is correlated with Kohat, Khulda and Habib Rahi Limestone with few different species of alveolina and nummulities. The depositional model shows that Alveolinal packstone is deposited in inner shallow platform whereas Nummulities grainstone indicates shoal and outer platform. The assilina of Middle Eocene are dominated by *Nummulities perforatus* and *Nummulities fabiani* indicating SBZ-19, Early Priabonian age. The SEM analysis shows the micrite crystals range from 1 to 20 µm. Anhedralmicrite grains shows irregular interlocking, whereas euhedral to subhedral crystals possess interconnected pores exhibiting good permeability for liquid and gas flow. The micrite limestone shows 2-10 µm wide micropores indicating both primary and solution enhanced intercrystalline porosity. The diagenetic processes, susceptible to dissolution, recrystallization and replacement show variation in porosity, mineralogy and chemistry of Kirthar limestone.

Geology and hydrocarbon prospects of Shaigalu and surrounding areas, District Zhob, Balochistan, Pakistan

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Abstract

The energy crisis has created havoc in the country. Everyone in Pakistan cries for energy and fuel. This dilemma has turned the high authorities of the government to think and manage to overcome the solution. Energy and fuel (oil and gas) paucity has made the citizens distressed, in such conditions the geological and engineering related forums have to make efforts for findings of new basins for oil and gas. In this context the Shaigalu and surrounding areas in Zhob District is proposed for detailed Geological Mapping to establish stratigraphic sequence and geophysical survey to interpret the structural setup of the basin.

The Shaigalu and the surrounding areas fall within the Lat 31˚00'N-31˚15'N and Long 68˚45'E-69˚00'E and is about 120 km southwest of Zhob city. The area is generally overlain by the sandstone and shale of the Shaigalu Formation, and shale, conglomerate / sandstone of the Bostan Formation. Broad synclines and tight anticlines with local faults exhibit the structural set up of the area. Nisai Formation of the Eocene and Murgha Faqirzai Formation of Oligocene age are exposed in the core of the anticlines with faulted contacts. The upper contact of the Murgha Faqirzai with the Shaigalu Formation of Oligocene, Miocene age is gradational. Bostan Formation (Pleistocene) is widely exposed in the broad synclines and is characterized by mute and buttes features. These synclines form large uneven plains and bad lands.

This area is situated close to Zhob Basin, represented by an anticlinorium, in which the geological sequence very silently shifts from older Triassic, Jurassic and Cretaceous Strata to Paleocene (Dungan Fm), Eocene (Nisai Fm), Oligocene (Murgha Faqirzai Fm), Miocene (Shaigalu Fm) and Pleistocene (Bostan Fm), towards the investigated area. The area is structurally not so much disturbed and shows rather complete stratigraphic sequence. The hydrocarbon potential occurs, in general, in cretaceous strata in Balochistan and to some extent the area can be related with the Karak-Kohat Basin, where oil and gas has been explored upto a depth of 4000 meters in Datta Formation (Jurassic) in Gurgori, Makori, Nashpa and Shakardara areas District Karak by MOL and OGDCL and production has been started for the last three years.

Owing to the similarities of the Shaigalu and surrounding areas with the Karak- Kohat Basin it is suggested that the Sharan Manda and Shne Bagh Shela areas may geophysically be surveyed for establishing the stratigraphic sequence and structures.

Preliminary geology and mineral potential of the Karezat and Barshor quadrangles toposheets 34N/6 and 5, district Pishin, Balochistan, Pakistan

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Abstract

The Karezat Quadrangle includes Khanozai and surrounding areas which are situated 70 kms northeast of Quetta on main Quetta-Zhob road. Barshor is a small town 80 kms north of Khanozai. The study area is covered by the rocks ranging in age from Triassic to recent/ subrecent. The geology and structure of the area is quite complex and has been visited by a number of earth scientist since independence and chromite deposits have been studied in detail.

The area can be divided structurally into three domains, Tungi-Ahmadun syncline area, Khanozai-Torkhula Ophiolite Segment and Murgha Zikriazai-Barshore Flysch Segment.

The Tungi-Ahmadun area is marked by a large local syncline, "The Tungi Syncline" which is represented by the Urak Formation of Pliocene where all the three members (Uzdapasha, Shinmati and Urak conglomerate) are exposed. The Urak Formation is thrusted by the Allozai Formation (Triassic) in the north and by the Parh/Bibai Fomation (Cretaceous) in the south. In the eastern corner it has thrusted contact with the Loralai (Jurassic), Sember, Bibai (Cretaceous) and Dungan (Paleocene) formations.

The Khanozai-Torkhula Ophiolite Segment is covered by the Allozai Formation (Limestone/ Shale of Triassic age frequently intruded by the Ultramafics), Loralai Formation (Jurassic limestone also intruded by the Volcanics) and Ultramafics (Cretaceous) having enormous potential of Chromite. In Khanozai and surroundings the ultramafic is spread on one third area of this segment and is part of the Muslim Bagh Ophiolite. The chromite is being mined for many years and needs new and modern mining techniques.

The Murgha Zikriazai-Barshor Flysch Segment (Pishin Flysch Segment) includes the Nisai Formation (Eocene), Murgha Faqirzai (Oligocene), Shaigalu Formation (Miocene). The Nisai Formation is comprised of fossiliferous limestone and shale at the base, thick sequence of multicolour shale in the middle and medium to thin bedded fine grained sandstone, shale, and brecciated cliff forming limestone at the upper part. It is followed by the various textured shale of the Murgha Faqirzai which is overlain by thick sequence of sandstone, shale and conglomerate of the Shaigalu Formation.

The central part of the Karezat Quadrangle is covered by alluvial cover which is represented by the Bostan Formation (Pleistocene) and recent to subrecent material. In the North of Khanozai, some structures exist which may be favourable sites for the hydrocarbons such as Ziba Tangi and Khudi Shaikh Nikka Ziarat areas. This part of the segment is recommended for Geophysical survey to show the subsurface sequence for interpreting the hydrocarbon potential.

Reserve estimation of tight gas reservoirs by flowing material balance equation and dynamic material balance equation; a comparative case study

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Abstract

Gas material balance equation (MBE) in conventional, volumetric reservoirs is described by a linear relationship between p/z and cumulative production. This study focuses on the reserve estimation in TGR by MBE which inherits very low permeability. Reserve estimation in tight gas reservoir by conventional MBE is not possible because less permeability of the reservoir does not allow measuring the average reservoir pressure due to the uneconomically long shut in times. This reason led us to develop a "flowing" material balance. It assumes the pseudo steady state flow prevails in the reservoir causing the change in average reservoir pressure which is equal to the change in the sandface flowing pressure and constant rate history is available. Flaw of this method is that constant rate is hardly maintained. This was covered by extending flowing MBE as "dynamic" MBE which is applicable to either constant flow rate or variable flow rate. After discussing the concept of reserve estimation by conventional, flowing and dynamic MBE a case study is presented that compares the results of both the new methods. Analysis was made using the "RTA" module of software FAST™ by Fekete Associates Inc. It was concluded that the flowing pressure can be converted to the average reservoir pressure and p/z plot can easily be generated without shutting-in the well to give reserves. But it is recommended that dynamic material balance should not be viewed as a replacement to buildup tests for pressure measurements, but as a very inexpensive supplement to them.

Regional transect through the Spanish Pyrenees and structural control on basin architecture

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Abstract

The Spanish Pyrenees shows very good development of pre, syn and post tectonic sedimentation within a Fold Thrust Belt. In this study geological maps, field observations and well data are utilized to construct a regional transect through the Spanish Pyrenees and to describe how structures modify the basin fill. The tectonic history of the Spanish Pyrenees begins with early rifting (250 Ma) which was followed by the main phase of compression (35 Ma). The northernmost part (hinterland) of the orogen, the Nougeras Zone (axial zone) shows evidence of antiformal stacking and thick skinned tectonics whereas the southern (foreland) Ager and Ebro basins show typical structures of thin skinned tectonics. A piggy-back basin termed as the Tremp Basin exists to the south of the Nougeras Zone. As the detachment horizon is provided by the Triassic Salt, the absence of Triassic salt in the frontal area resulted in the back-thrusting and thus a triangle zone exists between the frontal thrust to the north and the Ebro Basin to the south. The basin has undergone multiple phases of deformation during the collision tectonics. The compression utilized the preexisting structural weakness created during the earlier extension. The salt horizon present at base Triassic provides the detachment. This has resulted in the development of inversion structures as well as thickness variations. The progressive development of the Pyrenean Fold Thrust Belt resulted in well-developed syn-tectonic strata that help constrain the relative timing of the structures. The Garumnian growth strata show that the Boixol Thrust is older than the Montsec Thrust. The stratigraphy and geometry of the Boixol Anticline is the result of reactivation of the earlier normal fault. Intrabasinal structures such as the Boltana Anticline, Mediano Anticline and the Buil Syncline control the distribution and location of the sediments by modifying the paleoflow directions.

Use of remote sensing in monitoring frequency and distribution of dust storms over Southern Baluchistan

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Abstract

Dust storm is an environmental hazard that propagates with turbulent winds and obscures visibility less than 1km in severe conditions. Its occurrence depends on climatic and geological conditions of arid and semi-arid regions. Studying temporal and spatial extent of dust storm is essential in terms of assessing loss to human health, agriculture, industrial installations and communication sources. Remote sensing shows remarkable advantage in tracking previous event records and comparing it with present events. Identification of dust point sources can give information about chemical nature of storm and its subsequent effects. Areas having less than 100 mm annual rain are susceptible to dust activity as evident from storm cases and average rainfall in Southern Baluchistan. Based on temporal records, severe dust storms sometimes stay for two to three days which is critical in the hyper arid climate of Baluchistan where rainfall is scanty and wind speed is very low for quick dust fading. Aim of study was to find trends in occurrences of dust storms over Baluchistan from 2000 to 2013 by analyzing dust days record of MODIS data and ground observations. In the research, MOD021km terra product was used to develop catalogue of storm occurred over Baluchistan since 2000 after desiccation of Sistan Lake in Iran. Dust enhanced product was developed to trace source region and spatial extent of dust storm by using brightness temperature differences of thermal emissivity bands of MODIS sensor. Events recorded by MODIS were compared with storm occurrence records observed by existing eleven met observatories in Baluchistan and similar slightly decreasing trend was found. However, rise in dust storm frequency were observed at every three years' interval. One of the interesting facts is that before 2001, dust plumes of Sistan basin were localized to Iran but by 2002 onwards, they were expanding and approaching Baluchistan territory. Pre Monsoon and monsoon were active seasons when storm occurrence frequency was substantially high because it provides favorable atmospheric conditions for dust loadings. Lowest storm frequency was observed in the following years i.e. 2002, 2005, 2006 and 2009. Highest dust frequency was seen in years i.e. 2004 and 2008. Nonetheless, dense thick storm occurrence was observed in every year except 2006, in which no storm was observed. Dust frequency was higher in southern Pakistan in comparison to eastern Pakistan. Thus, Baluchistan is most vulnerable province to white sand and dust particles originated from dry lake beds of Sistan basin and Hamun wetlands. Adjacent to those dry lake beds, Chagai, Nushki, Panjgur, Washuk and Kharan districts were most frequently hit by storm. Storm monitoring can assist in understanding dust pathways for development of prediction systems in this way; it can help planners and decision makers in preventing its damages to the environment. There is a pressing need to adopt protective measures against dust storms for minimizing mortality rates of humans and its hazardous effects to physical and biological environment of Baluchistan.

Assessment of drinking water quality of Drosh and Asheriat district Chitral Pakistan

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Abstract

Current study has been conducted to investigate the water quality of Drosh and Asheriat district Chitral. In study area exposed lithologies (mafic and ultramafic rocks) and their mineral content may affect the surface and ground water through leaching and weathering. About 65 water samples were collected from different water sources (springs, rivers, streams, tube wells) from Drosh and Asheriat. All the samples were analyzed for physico-chemical parameters using standard methods. Total and fecal coliform analysis were carried out for fifteen samples by using multiple tube fermentation technique for water and wastewater. The concentration of heavy and trace elements were determined using Perkin Elmer Atomic Absorption Spectrometer (AAS-700).

The results of physico-chemical analysis showed that the concentration of pH, Temp, EC, TDS, Salinity, Chloride, Nitrate, Sulfate, Phosphate, TSS in Drosh and Asheriat were found within permissible limit as suggested by WHO 2004 and USEPA 2009. However turbidity was found above permissible limit in 66% from Drosh area and 78% from Asheriat. Results of heavy metals from Drosh indicated that the concentration of Ni, Pb, Cd, Co, Cr, Cu, Zn, Mn, Fe were having mean values (ppb) 7.97, 0.73, 0.23, 0.06, 4.04, 79.01, 210.6, 2.72, 8.48 respectively. The concentration of light elements such as Na, K, Ca, Mg were having mean values (ppm) 20.44, 8.01, 104.67, 36.7. The mean concentration (ppb) of Ni, Pb, Cd, Co, Cr, Cu, Zn, Mn, Fe from Asheriat area is 16.92, 0.96, 0.29, 0.05, 5.05, 100.04, 266.7, 3.41, 10.67. While the mean concentration (ppm) of Na, K, Ca, Mg is 17.95, 8.42, 94.7, 17.96. The results of total and fecal coliform analysis showed that maximum probability number (MPN/100ml) in fifteen samples ranges from 0-1800. Majority of the heavy metals in all samples are below permissible limits as suggested by WHO and USEPA. However Ni was found above the permissible limit in 8% from Drosh and 7% from Asheriat and Ca were found above permissible limit in 75% from Drosh and 71% Asheriat area. Mg was found above permissible limit in 8% samples from Drosh area. The excessive intake of heavy metals can cause toxicity and also effect human health. For instance Ni can cause lung and nasal cancer, Mg can cause hypertension and cardiovascular diseases Ca can cause nephrolithiasis and colorectal cancer. Microbial contamination (E.coli) can cause water borne diseses such as diarrhea, gastroenteristis and typhoid.

On the basis of all these results, it is concluded that drinking water of both Drosh and Asheriat are contaminated with Ni, Ca, Mg and fecal coliform. Therefore monitoring of drinking water in the study area should be performed regularly. Boiling is recommended to reduce the level of contamination in drinking water. The strong association of Ni, Ca and Mg in drinking water of the study area is indicative of geogenic contamination.

Temperature trend of last 60 years in Peshawar

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Abstract

This paper presents trends calculated for the 60-year period of temperature data (1950-2010). The change in temperature has been assessed worldwide to minimize its adverse effects on earth's environment. The study of temperature trends is important to search out paleoenvironmental insights as well as vulnerability of hazardous geological and geomorphologic activities such as mass movement, glacial outburst floods and seismic activity. Thus, Peshawar which is provincial Capital, the largest city with 11.38 percent population of NWFP, should be analyzed as it may be particularly vulnerable to and at risk from temperature change. The objective of the study was to examine the recent trends of mean annual, minimum, and maximum temperatures for Peshawar district in last sixty years (1950-2010) using data collected for single station from Regional Meteorological Center (RMC), Peshawar. Analysis is done to evaluate and assess increasing or decreasing trend in Mean Annual, Mean Maximum and Mean minimum in past years using linear regression Statistical test. Results exhibit warming trend for whole period for Mean annual, Mean Maximum and mean minimum temperatures as after every 12 months in year, a 1.4 ^{o}C increase in all indices has been seen, holding all other variables constant. Furthermore, results of month wise analysis for whole selected period shows, December is most susceptible for getting warmer. On the other hand, July is least observed for getting warmer with time.

Social vulnerability assessment for disaster management using GIS: A case study of Nala Lai Rawalpindi

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Abstract

The most momentous force of natural disasters is at the local level, where human settlements are smashed and livelihoods are put at risk, economic losses are ensued, and there may be injuries or loss of life in the affected areas. Disaster management often only covers the physical component of hazard; which the social vulnerability component is usually unnoticed. Life pattern of some people can put them more at risk during disasters than others. As damages vary geographically, over time, and among different social groups, vulnerability also varies over time and space. In the current study the socioeconomic and demographic factors that affect the resilience of communities were used along with GIS databases to address the social vulnerability of people living around Nala Lai Rawalpindi area. Social variables (gender, age, sanitation conditions, income, housing type, education, no. of spouse) were collected at individual house level. These social variables were used in weighted overlays in GIS environment to create social vulnerability maps that can facilitate target policy to assist vulnerable populations. It is strongly recommended that the emergency management authorities should understand life pattern in vulnerable areas to efficiently and impartially manage the resources.